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ABSTRACT

The State Planning System (SPS) is a flexible, policy-oriented management tool intended to help analyze possible impacts of various policy decisions. The SPS is able to address a wide range of issues because it depends on the user to provide the relationships and data to be used in the analysis. Such issues might include enrollment shifts among educational institutions, competition among state-funded services for scarce monies, and student/taxpayer share of higher education costs. Chapter II emphasizes SPS as a planning framework in which many sets of relationships or equations can be used. In Chapter III, a simple policy problem is examined as a way of describing the calculation capabilities of the SPS. Chapter IV describes the report preparation capability of the SPS and its ability to link to other reporting systems. Chapter V presents a summary of pilot-test case studies as examples of the kinds of questions that might be addressed in using the SPS as an impact calculator. Chapter VI reviews the National Center for Higher Education Management Systems (NCHEMS) implementation policy for the SPS. A glossary is included containing terms associated with the SPS. (Author/CMV)

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INTRODUCTION TO THE STATE PLANNING SYSTEM

Technical Report 86

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PREFACE

The State Planning System (SPS) is designed to assist state-level postsecondary education planners in the analysis of issues and problems. The user selects and describes the issue to be addressed, designs the analytical framework that will yield the desired results, selects the variables, assigns values to each, and provides the data. The SPS software and associated documentation help organize the data to support the design. The software then analyzes the data through its simulation and optimization capabilities and provides a flexible set of reporting formats in which to display the results.

The SPS is not a specific model or analytical construct. Rather, it becomes a "model" once the user selects the design that will best address the problem or opportunity to be analyzed. Thus the SPS, which can be used in day-to-day data analysis or to model complex state-level problems, places no a priori requirements on the particular data or design that must be used and can become as many models as the user needs to address a series of issues.

The SPS is designed to be implemented on a wide variety of computer systems with little or no modification. It can operate in interactive or batch mode, is written in ANSI FORTRAN, and has been installed on IBM, Control Data, Honeywell, and UNIVAC computer systems. A fairly large capacity computer system is required since the programs may take as much as 30,000 words of storage.

Installation of the SPS software does not automatically provide the user with the background necessary to fit the SPS to a specific problem. As in any modeling effort, available data and the nature of the selected design relationships may limit the applicability or accuracy of the results. Some staff capability in operations research or computer sciences is useful. Also, users can obtain assistance from NCHEMS staff to initially install the SPS and to help develop the designs necessary to address specific state problems.

The SPS was developed by Dr. Vaughn Huckfeldt (formerly with NCHEMS and now director of the National Policy Analysis Center, Boulder, Colorado) and by Mark Chisholm, Ellen Cherin, and Roger Bassett of NCHEMS. The development process for the SPS began in late 1972 with the National Planning Model project, which was under a contract with the U.S. Office of Education. That initial work resulted in a prototype operational model for use in analyzing the effects of alternative financing plans on access to higher education.

In 1974, development of the State Postsecondary Education Planning Model (SPEPM) was funded under a contract with the National Institute of Education. The developmental work was completed in early 1975 and the software was pilot tested in Colorado, Maryland, and New York in late 1975 and early 1976. The SPS was successfully implemented and used in each of these states and has since been implemented in Oklahoma, Virginia, Minnesota, and South Dakota. In late 1976, the project name was changed to the State Planning System to avoid the confusion caused by the word "model" in the project name.

Major developmental contributions were made by three people outside NCHEMS. Dr. George Weathersby of Harvard University (recently director of the Office of Research for the presidentially appointed National Commission on the Financing of Postsecondary Education) contributed to the planning philosophy of the National Planning Model. Dr. Salvatore Corallo of the U.S. Office of Education added to NCHEMS's knowledge of planning model concepts. And Dr. Leon S. Lasdon of Case Western Reserve University contributed to the development of the nonlinear dynamic optimization algorithm and to the review of the SPS software.

The production schedule for this and other documents related to the SPS was reviewed with the Fiscal Affairs and Operations Committee of the NCHEMS Board of Directors at its October 1976

meeting, and the software and supporting documents have been approved for release by the NCHEMS Board of Directors.

The Center has tested the software to determine that it operates as the documentation indicates. The Center will notify users of any potential problems in the software and will make any necessary changes after initial release. No warranty, expressed or implied, is provided with the software.

The *Introduction to SPS* (NCHEMS Technical Report 86), The *Modeling and SPS* (NCHEMS Technical Report 89), and The *SPS Case Studies* (NCHEMS Technical Report 91) will go to the holders of 1976 subscriptions to NCHEMS publications. All 12 SPS documents (the documents are described and diagrammed inside the cover) and the SPS distribution tape, containing the software and several test designs, can be purchased at cost, either individually or as a set, by any interested party. In addition, implementation assistance for the SPS can be purchased from NCHEMS. This assistance, which based on the pilot-test experience, is strongly advised, can consist of NCHEMS staff days and travel to assist in:

1. Installing the software
2. Conducting a training seminar
3. Conducting a design seminar
4. Assembling data
5. Entering the initial design and data
6. Validating and modifying the intitial design
7. Analyzing the results

The following are NCHEMS documents that are superceded by the SPS documents listed inside the front cover:

Cherin, Ellen; Chisholm, Mark; Huckfeldt, Vaughn; and Smith, Mark. *State Postsecondary Education Planning Model Software System.* Boulder, Colo.: National Center for Higher Education Management Systems [NCHEMS] at Western Interstate Commission for Higher Education [WICHE], 1975.

Chisholm, Mark. *State Postsecondary Education Planning Model Software Documentation.* NCHEMS Technical Report 80. Boulder, Colo.: NCHEMS at WICHE, 1976.

Huckfeldt, Vaughn. *A Preliminary Framework for the State Postsecondary Education Planning Model.* Boulder, Colo.: NCHEMS at WICHE, 1974.

_____. *An Introduction to the State Postsecondary Education Planning Model.* NCHEMS Technical Report 77. Boulder, Colo.: NCHEMS at WICHE, 1976.

_____. *A Design Guide for the State Postsecondary Education Planning Model.* NCHEMS Technical Report 78. Boulder, Colo.: NCHEMS at WICHE, 1976.

_____. *State Postsecondary Education Planning Model Training Manual.* NCHEMS Technical Report 79. Boulder, Colo.: NCHEMS at WICHE, 1976.

Huckfeldt, Vaughn; Cherin, Ellen; and Chisholm, Mark. *State Planning System Case Studies.* NCHEMS Technical Report 81. Boulder, Colo.: NCHEMS at WICHE, 1976.

Huckfeldt, Vaughn; Cherin, Ellen; and Chisholm, Mark. *State Planning System Data Procedures.* NCHEMS Technical Report 82. Boulder, Colo.: NCHEMS at WICHE, 1976.

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The State Planning System (SPS) is the result of the combined efforts of many individuals. In particular, the representatives from the SPS pilot-test states were most helpful in their use of earlier test versions of the software, and in providing their guidance, review comments, and suggestions concerning documentation. Since each pilot-test state user was required to develop a specific set of design relationships for a particular problem, the extent of their efforts went beyond the normal pilot-test commitment and deserves special acknowledgement. Those involved from each of the states were:

Colorado Commission for Higher Education:
- Dr. Frank Abbott, Executive Director
- Dr. William Adrian
- Mr. Edward Lyell
- Mr. Carleton Ekberg

Maryland State Board for Higher Education:
- Dr. Sheldon H. Knorr, Commissioner of Higher Education
- Mr. John E. Clayton
- Dr. Stephen R. Hample
- Mr. B. Kerry Gustafson

New York Department of Education:
- Dr. William Fuller, Associate Commissioner
- Dr. Paul Wing
- Mr. Michael Cruskie
- Dr. Shimon Awerbuch
- Mr. Steve Cohen
- Ms. Jackie Skolnik
- Ms. Judy Hutchison

Significant ideas for the construction of the SPS were provided by Kent Weldon and Mark Smith of NCHEMS. Kent Weldon worked on the development of the National Planning Model and made many valuable suggestions regarding the SPS, and Mark Smith worked on the development of an early pilot-test version. Dr. Melvin D. Orwig has been the NCHEMS Associate Director responsible for the SPS since June 1975, and his guidance and patience are most appreciated. Other staff at NCHEMS who have contributed to the development of the SPS are Dr. Allan Service, Dr. Kent Caruthers, Dr. Robert Gray, Marilyn McCoy, and David Makowski.

The production of the SPS documents has been a lengthy and difficult task, and special thanks are extended to Cynthia Labuda for her work in preparing the tables, figures, and charts, coordinating the lengthy process of draft production, as well as typing the documents. Additional acknowledgements are given to: William Johnston, Jean Strueber, and Maureen Byers for editorial assistance, Clara Roberts for assisting in the overall coordination of the document production, Elizabeth Peto for typesetting several of the documents, and Paula Dressler for typing several early drafts of the SPS documents. Many other people, too numerous to mention, were involved in the project at one time or another, and their help has also been appreciated. It should be emphasized, however, that any mistakes or errors in the documents are the sole responsibility of the authors.

Chapter I

Introduction

The State Planning System (SPS) is a flexible, policy-oriented management tool intended to help analyze possible impacts of various policy decisions. Its development and initial applications have focused on the complex, interrelated effects of alternative state-level financing policies on state educational goals. It could also be used by an individual institution to look at the impact of a proposed policy on that institution or by an executive, legislative, governing, or coordinating agency staff to look at the impacts of proposed postsecondary education polices in general.

With the increasing state-level presence in postsecondary education comes an increasing complexity of issues to be analyzed; an increasing need to know the interrelationships among issues; an increasing need to know the differential impacts of a set of decisions on different institutions or sectors; and, since so much of the decision process depends on the intuitive judgment of a decision maker, an increasing need to develop and display alternative courses of action among which choices can be made.

Questions develop in different forms, and answers to them require an ability to analyze a variety of complex, interrelated issues. Examples of the issues now being faced in states across the country are: (1) enrollment shifts among institutions derived in part from geographic migration and/or programmatic demands prompted by changing student interests and new manpower requirements in a rapidly changing society, (2) competition among state services for scarce state dollars, (3) the proportion of costs to be paid by students and taxpayers, (4) concerns about faculty turnover, and (5) the effects and prospects of continued federal funding.

The SPS might address these issues as follows:

(1) *Enrollment Shifts.* An analysis of the effects of external conditions on historically-based enrollment trend projections.

(2) *Competition among state-funded services for scarce dollars.* An analysis of the distribution of projected revenue among all state-funded social services (including postsecondary education), using various assumptions regarding state tax base, state tax structure, changing costs and the known or implied appropriations priority assigned to each service.

(3) *Student/taxpayer share of postsecondary costs.* An analysis of the elasticity of student response to various combinations of public funding and student support; including the implications of various tuition levels for the student's ability-to-pay, the state's tax base, and the state's goals for access to postsecondary education.

(4) *Faculty Turnover.* An analysis of proposed changes in tenure policies on faculty turnover experience, based upon assumed changes in student-faculty ratios and tenured-total faculty ratios.

(5) *Federal Funding Prospects.* An analysis of the effect of changes in the amount of, and conditions attached to, federal programmatic funding on the net cash balance of postsecondary education and on student price responses to postsecondary education.

The SPS can address such a wide range of issues because it depends on the user to provide the relationships and data to be used in the analysis.

But even with the time commitment necessary to develop data and relationships, the time needed to address complex issues such as these with the SPS will usually be no greater than the effort involved in manually computing the impact of one less complex policy alternative. The SPS assists a state by reducing much of the special purpose computer programming that might otherwise be necessary to complete a policy analysis effort. The SPS software already contains the necessary data input structures and report generating capabilities, thereby increasing the time available for developing design relationships and analyzing results.

And an indirect, but important, benefit of the SPS is the communication and understanding between analysts and policy makers that is necessary to develop the required set of design relationships for any particular problem.

Among the other possible direct and indirect benefits of the SPS are its contribution to improved state-level analysis and more systematic planning; the capacity it provides to include actual interrelationships and decision alternatives in the planning and analysis process; the visibility it gives to the dynamic multi-year impact of planning decisions; the documentation it provides of the planning process; the shift in analytical emphasis it allows from the development of computer programs to actual analysis of state-level relationships; the ease with which design relationships can be modified and reports generated to better meet the preferences of different target audiences; the ability of the user to match the design to reduce the need to collect new data; and the ease with which it can be installed on an appropriate computer system accessible to the user.

Chapter II contains a short discussion of the SPS to emphasize that this is a planning framework in which many sets of relationships or equations can be used. In Chapter III, a simple policy problem is examined as a way of describing the calculation capabilities of the SPS. Chapter IV describes the report preparation capability of the SPS and its ability to link to other reporting systems. Chapter V presents a summary of the pilot test case studies as examples of the kinds of questions that might be addressed in using the SPS as a calculator. And finally, Chapter VI reviews the NCHEMS implementation policy for the SPS.

Chapter II

The Capabilities and Limitations of the SPS

The State Planning System (SPS) can be adapted to each state's state-level planning arrangement, whatever that arrangement happens to be. A major reason for this flexibility is the ability of the SPS computer programs to accept *state-specified* data and relationships as input, thereby overcoming the limitations of planning calculators with built-in relationships that can be changed only through costly and time-consuming reprogramming.

The requirement that the user thoughtfully define the analytical approach and specify the required design equations and data requirements has another desirable effect besides flexibility. The SPS results are less mysterious and so are more easily evaluated and related to the assumptions on which the design is based.

The user specifies the data required for each design or model to be run on the SPS. The data required will vary with each application. For example, a user might select from among any of the following sources and types of data to support a particular design: existing institutional or state data on faculty, students, facilities, finances, objectives, and outcomes; national data provided by the National Education Data Library (NEDL); or data from special studies of the specifics of some aspect of postsecondary education (such as the response of students to tuition increases, student demand studies, and forecasts of state and federal revenues). The important point is that the user draws from existing sources of data to create a special data base for each design. The SPS software helps with this task by guiding the construction of the necessary computer files.

Whether installing an existing analytical design or creating a new one, the user's active involvement in choices among design alternatives, and the data requirements for each, help achieve a workable match between size and cost of a design and the acceptable level of sensitivity of the results. In fact, the SPS can be used to test the sensitivity of selected variables on analytical results, one way of determining the potential value of adding variables to the analysis or new data elements to an on-going state-level data base in future years.

A typical SPS application requires the user agency staff to identify measurable variables that reflect the current state of the system, the controlled decisions affecting the system, and the external factors that impact upon the system. Specific equations must be developed that accurately portray the impact of controlled decisions and external factors on the state of the system at some future time. If a user does not have the existing staff skills necessary to complete these tasks, NCHEMS staff may be able to provide design assistance at a negotiated fee.

The SPS software should not be used without due consideration given to (1) the assumptions incorporated in the design relationships by the user, (2) the limitations placed on the analysis by currently available data, and (3) the ability of user staff analysts to develop relationships that are based on valid assumptions. Since the SPS requires the user to develop the specific design relationships, NCHEMS cannot be responsible for analytical results that are unsatisfactory due to any of the above considerations or to incorrectly specified relationships.

The SPS does have practical limitations on the maximum size problem that can be analyzed at one time. A software design that is very detailed and which contains many relationships may require a larger computer capacity than is available. For example, the RRPM (Resource Requirements Prediction Model) can be processed interactively for as many years into the future as desired. One limitation in using the SPS software is that all the relationships and data for one design must fit within the available computer storage simultaneously. This limits the level of detail in which RRPM can be run using the SPS. Also, using the SPS to analyze

changes in the structure of a system (such as adding new institutions or deleting an institution) involves more relationships and is therefore more difficult than an examination of variations within an existing system.

Responsiveness of the SPS to Different Levels of Design Complexity

The following example is intended to illustrate that the SPS will function properly with design relationships over a wide range of complexity. As mentioned earlier, the selection of the proper relationship is the task of the policy maker with the assistance of an experienced policy analyst.

Using enrollment forecasting as an example, consider that three levels of complexity could be employed:

(1) A simple trend projection relationship
(2) A population participation rate relationship
(3) A supply and price sensitive demand relationship

The simple trend projection relationship uses actual historical enrollment points for the past several years as illustrated in Figure 1. The trend projection method assumes that the average enrollment in future years will follow the historical pattern and can therefore be estimated by projecting that trend line into the future.

There are disadvantages to this method (for example, the assumption that the average trend will continue may be incorrect), but it is a design relationship that is often used.

The population participation rate relationship assumes that shifts could occur in the trend line as a result of changes in the number of individuals in the college age population. Historical data might be used to calculate the trend of the participation rate. This projected rate would then be multiplied against a projection of the total state population (possibly limited to the 17- to 35-year-old category) to calculate the forecasted enrollment as shown in Figure 2.

The supply and price sensitive demand relationship is more demanding both in terms of the relationships and the availability of data. First, it considers that the estimated enrollment predicted in the second example may not be realized if the institution does not admit all of the population that desires to enroll, e.g., the supply of spaces for students or capacity of the educational system may be limited. In addition, the policy maker may wish to explore the effects on participation rates of changes in the tuition level and other costs of attending postsecondary education. Note that neither of the previous two design relationships would accommodate such a detailed policy analysis. The relationship for such an example design might be as shown in Figure 3.

Several other enrollment projection methods could be used. NCHEMS is not recommending any particular one of these examples. They are used here only to illustrate different levels of complexity in the design relationships that might be selected to solve the same problem. The important point to note is that the SPS can be used to analyze any of these relationships.

Figure 1
Enrollment Trend Projections

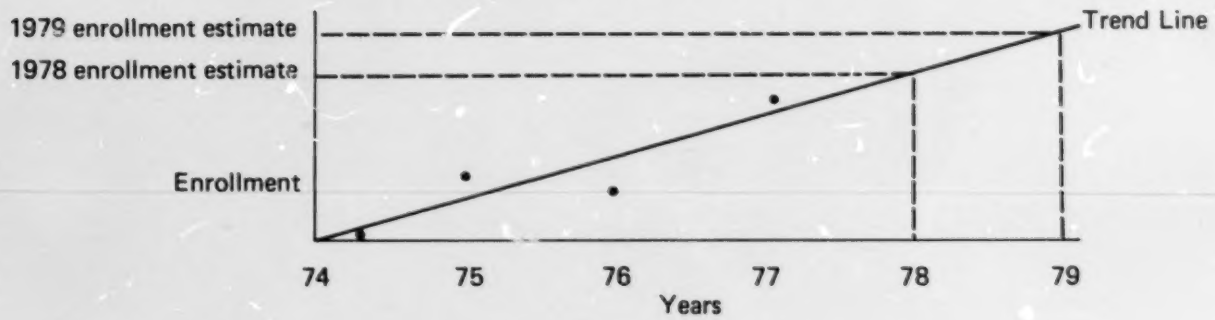
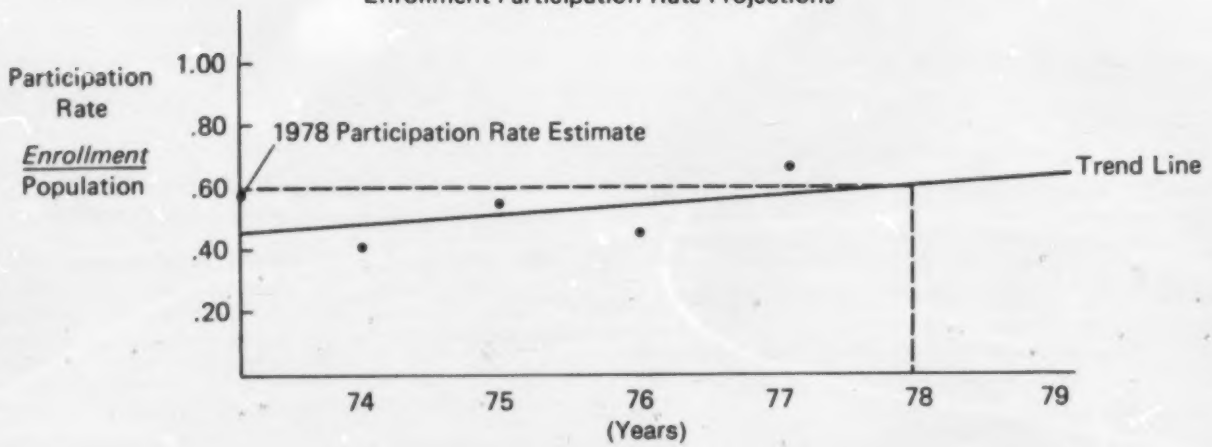
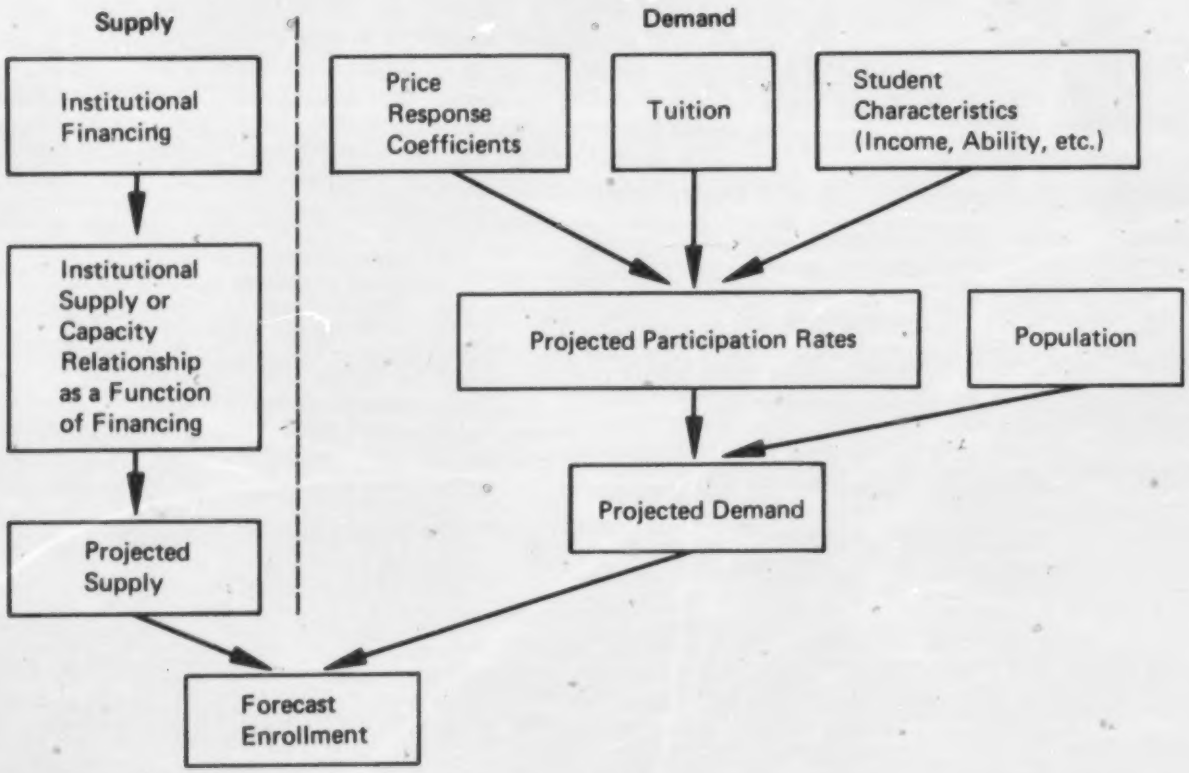


Figure 2
Enrollment Participation Rate Projections



Projected 1978 Enrollment = 1978 Participation Rate Estimate X 1978 Population of 17 to 35-Year-Olds

Figure 3
Supply and Demand Enrollment Forecasting



The above examples and the case studies described in Chapter V indicate the flexibility of the SPS as a planning framework. The effectiveness of that framework in the analysis of the impact of state-level policy decisions on students and institutions is dependent on the data and design relationships developed by a state-level user.

What Alternatives Might Be Used In Place of the SPS?

Chapter V contains a description of a few alternative tools to the SPS, including those considered by the Colorado Commission on Higher Education and the Huff adaptation of RRPM as a state-level tool for estimating required resources and associated budgets. Some states have used the institutional planning model "CAMPUS" for resource requirements analysis. Also, the access model developed by the President's National Commission on the Financing of Postsecondary Education has been used by several states to investigate potential changes in enrollment caused by changes in tuition or student aid. Other states have developed computer software for a specific analysis problem. This has, in some cases, been a small task as in the development of the Tenure Percentage Projection Model in Virginia (discussed in Chapter V) or so complex as to take several years of effort.

Further information on the status of mathematical modeling efforts at the state level is contained in *Modeling and SPS*, Technical Report 89. This report contains a summary of the results of a 1976 conference (sponsored by the Education Commission of the States and NCHEMS) on state educational modeling.

Use of the SPS for Other Than State-Level Postsecondary Education Analysis

The flexibility of the SPS makes it theoretically useful in any area and at any level in which policy analysis can benefit from calculations or reports similar to those described in the text. In the process of development (and to illustrate its applicability to other areas), the SPS has been used by a local county sheriff's office and an industrial manufacturer to successfully establish long-range master plans. These applications involved the use of the SPS by individuals unfamiliar with computerized planning. The ease with which the system adapted to these new areas greatly assisted the normal planning process and saved staff time.

However, the SPS has been formally tested and shown to be effective in assisting higher education policy analysis only at the state level. So, from NCHEMS' point of view, the SPS is approved by the NCHEMS Board of Directors as a useful product only at the state level, and applications at other levels are made at the risk of the user.

Chapter III

The SPS Calculation Module

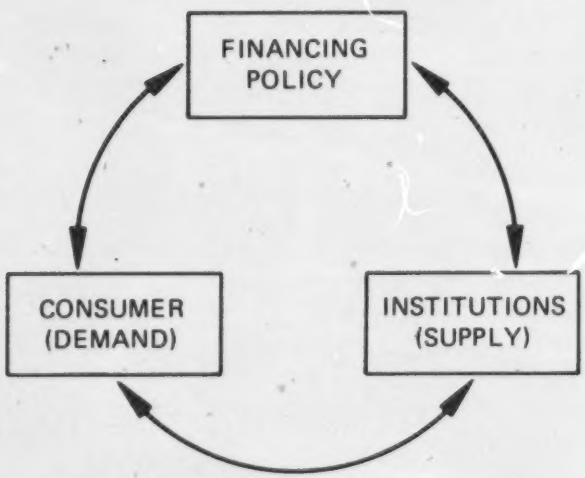
The previous chapters have generally described the planning framework provided by the SPS. In this chapter, an example policy problem is used to illustrate how a user would develop an SPS design for the SPS calculation module.

In approaching any problem, consideration must be given to each of its components, to the interrelationships among the components, and to the alternatives available for reaching a practical and feasible solution. One purpose of the SPS is to replicate the interrelationships among policy problem components and to observe the impacts of alternative solutions. For the example described in this chapter, the components are:

(1) Financing policies
(2) Institutions (the supply of services available)
(3) Consumers (the demand for services available)

Figure 4

Example Policy Problem Components



Each component is an area in which day-to-day decisions are made and objectives are achieved. Yet a decision in one impacts each of the others and the nature of the interrelationships among components is a major factor in determining the preferable alternative course of action.

Consider, for example, a student's choice of institution or of major. The characteristics of the student making the decision are contributing factors in determining the choice. But students are also influenced by certain institutional factors such as the cost of attending, program choices offered, and the makeup of the student body. The student's decision can also be influenced by current state financing policy, e.g., student grants to attend some types of institutions.

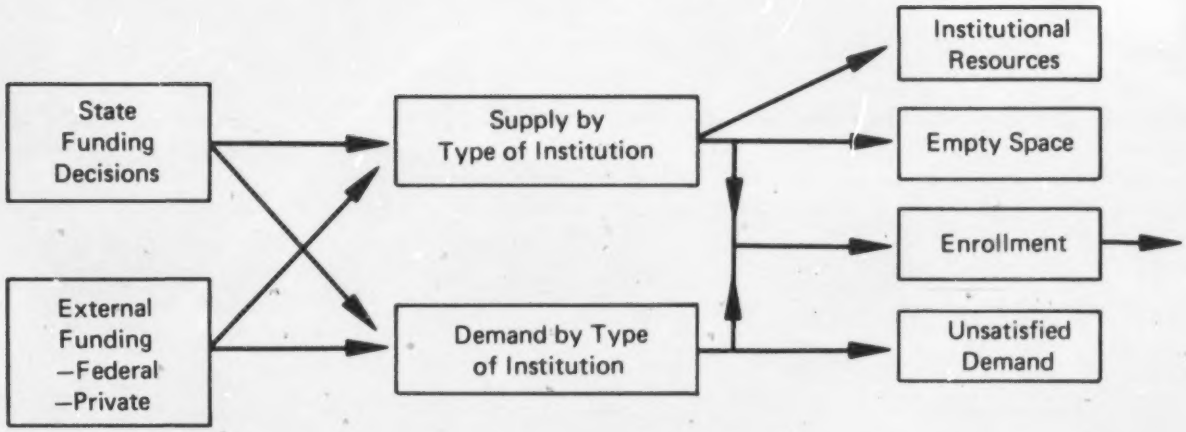
An adequate evaluation of financing alternatives in this example policy problem requires estimates of the impacts of each alternative on the supply and demand components. Figure 5 displays some of these more complex interrelationships.

Some analytical tasks will be much more complex than that displayed in Figure 5 and may even be beyond available data or the analysts' understanding of current conditions and the educational system. But in most cases, the user staff can adapt a design to reconcile the necessary level of complexity to available data and existing staff analytical skills, producing acceptable, useful results.

In the illustrative example displayed in Figure 5, the component interrelationships are driven by state policies. A state funding alternative is selected for analysis. The impact of external funding sources is specified by providing assumed levels of revenue for each external source (in this example, federal and private). The SPS calculation module is then used to test these state and external revenue assumptions to see in what way they influence institutions and students toward certain courses of action.

Figure 5

State-Level Component Interrelationships



To prepare this example analysis for the SPS calculation module, the user would first specify a set of equations to calculate the supply of student spaces and the enrollment demand by type of postsecondary education institution. The supply equations contain the financial support assumptions necessary to estimate the institutional resource requirements for a given level of supply. These equations, and the variables within them, are the SPS design. When the SPS run is made, the relationships within the SPS software will calculate the supply and demand for postsecondary education for each of the institutional types, and then will compare the supply and demand estimates to produce forecasts of (1) enrollment by type of institution, (2) the number of empty spaces by type of institution, (3) the unsatisfied demand by type of student, and (4) estimates of the institutional resources required to meet the forecasted supply commitments.

But a user might want to display the consequences of several alternative state funding actions on state goals for postsecondary education. Then, the example policy problem could be stated as follows:

> What level of state student aid in dollars per student and state institutional aid in total budget dollars to institutions will come closest to achieving state goals related to:
>
> Access to higher education
> Quality of instruction
> Financial solvency of institutions

In the example being used in this chapter, the problem is addressed at the highest level of aggregation (that is, all institutions are grouped together in one category). In actual SPS applications, the appropriate level of aggregation is an important design question to be decided by the user. Institutions can be considered individually, or be grouped into sectors (e.g., by public and private or by two-year, four-year, and university). State student aid may be given in many forms and in different amounts or, as in this example, be represented by average dollars of aid per student. In a similar fashion, this example aggregates the many institutional budget categories into one total state general institutional appropriation. The user must carefully choose the level of aggregation that achieves the best balance among desired analytical results, staff capabilities, and computer capacity.

Since the focus in this SPS example is to examine alternative resource allocation levels in terms of their effect on specified state goals, the goals must be quantified in an acceptable way. Figure 6 displays one set of goal measures. Obviously, other measures could be used if data were available. Access could, for example, be measured as the ratio of enrollment to the 18 to 21-year-old population.

The access measure used in this example takes the ratio of the total enrollment of 118,000 students to the total state population of 2,400,000. As the ratio

Figure 6

Specification of Measures

State Goal	Measures	Current Values	Target Values 1973-1976
Access	Total Enrollment / Total Population	118,000 / 2,400,000 = 1 / 20	1 / 17
Quality	Total Faculty / Total Students	6,653 / 118,000 = 1 / 18	1 / 20
Financial Solvency	End of Year Net Cash Balance	$34 Million	$1 Million

1 to 20 increases, the access increases and vice versa. The selection of specific acceptable measures for each state goal to be used in a design relationship is a task that must be completed by each state. Note that the SPS does *not* require the use of any specific state goals and the goals included here are only intended to serve as examples.

The 6,653 faculty in the institutions with an enrollment of 118,000 students provide a faculty-student ratio of 1 to 18, which is used as a base level measure of quality. As this ratio increases, quality will be assumed to increase and vice versa. At the end of the year the total net cash balance for all of the institutions is computed to be $34,000,000. The net cash balance referred to is, for any one time period, the revenue, including what was brought forward into the year, minus the expenditures.

For this example, the hypothetical targets set are used to start planning in 1973 and continue through 1976. Assume the access measure is to improve from a ratio of 1 in 20 to 1 in 17. Also, in a hypothetical planning sense, a small sacrifice is to be made on the quality measure by letting it go to 1 in 20. Finally, a positive net cash balance at the end of the year is desired but a balance of $1,000,000 is considered to be adequate.

The specification of the simple design for this policy problem includes the following:

1. All higher education institutions are aggregated together.
2. The goals are: access, quality, and financial solvency of institutions.
3. The state decision variables are: state student aid in dollars per student and state institutional aid.
4. Student demand is calculated and is affected by a stated price response to the cost of attending an institution.
5. A faculty flow relationship is determined, which includes institutional decisions on the number of faculty hired.
6. The end of the year net cash balance is calculated.

In addition to the grouping of institutions and the specification of measures, the decision variables must include both political and economic limits on their ranges. For example, state student aid is certainly going to change, but by how much? Can it be increased by 50%? That may be feasible in a political realm, but may not be economically possible for the state. Can it be cut by 50%? That may be feasible economically but probably is not reasonable politically. The SPS allows both political and economic constraints to be included within a design, leading to more realistic results.

Relationships are also needed to estimate students, faculty, and finances over the next few years—relationships, for example, that give the flow of students from one time period to the next. An illustration of what is meant by the flow of students is shown in the first line of Figure 7. This simple relationship takes percentages of students

Figure 7

Student Flow Design

Student Flow Equation:

	Continuation Rate for Continuing Students	×	Students Continuing in 1973	+	Continuation Rate for First- Time Students	×	First-Time Students in 1973	=	Students Continuing to 1974
Example:	.80	×	94,000	+	.69	×	26,880	=	93,747

Including Student Price Response:

	First-Time Students in 1973	—	(Price Response Rate	×	Change in Net Cost of Higher Education	×	First-Time Students in 1973)		
Example:	24,000	—	(.0012	×	–$100)	×	24,000	=	26,880

Change in Net Cost of Higher Education:

	(New Tuition — New Student Aid)	—	(Initial Tuition — Initial Student Aid)		
Example:	($644 — $144)	—	($644 — $44)	=	–$100

continuing from 1972 into 1973 and of new students in 1973 to project the number of students that would continue into 1974. Based on historic trends, for example, 69% of the 1973 first-time students would continue in 1974, and 80% of the continuing students will go to school in 1974, resulting in 93,747 students continuing from 1973 into 1974. This calculation would then be repeated for each additional time period (in this case, 1975 and 1976).

The relationship used in this example expands the simple flow relationship to include a student price response to reflect the change in the number of first-time students resulting from a change in the net cost of attending higher education (that is, a reduction in the cost of higher education, based on the price coefficients used in the example, would result in an increased number of first-time students). For example, an increase of state student aid of $100 (from $44 per student to $144 per student) results in a net reduction of the cost of higher education to the student of $100. When the price change is applied to the student price response,* the previously predicted number of new students (24,000) is increased to 26,880. Notice the impact on the number of students in the coming year of the first state decision variable (state student aid) as incorporated in the design relationships.

*See the *State Planning System Data Procedures* for a discussion of price response coefficients and references to available data.

The flow of faculty, illustrated in Figure 8, uses the same basic relationship. An institutional response to a change in state institutional funding is represented as a change in the number of new faculty actually hired. As the example illustrates, a possible net increase in institutional funding by $1,000,000 might increase new faculty from 660 to 667. Here the second state decision variable (state institutional aid) enters the design and has an impact on the total number of faculty. Obviously most of the $1,000,000 would be used for expenses other than the seven new faculty members, but this illustrates one possible relationship that may exist between state funding and the number of new faculty.

As important as the flow of students and faculty is the calculation of the institutional financial flow. Shown in Figure 9, it is very simple and considers

Figure 8

Faculty Flow Design

Standard Faculty Flow:

	Continuation Rate for Continuing Faculty		Faculty Continuing To 1973		Continuation Rate for New Faculty		New Faculty In 1973		Faculty Continuing In 1974
Example:	.92	x	5940	+	.72	x	667	=	5945

Including Institutional Response to Changes in State Funding:

	New Faculty In 1973		Rate of Response to Financing Changes		Net Change in Institutional Financing		New Faculty In 1973		
Example:	660	+	(.000,000,01	x	$1,000,000)	x	660	=	667

Change in Institutional Financing:

	New State Aid to Institutions	—	Initial State Aid to Institutions	+	Net Cash Balance		
Example:	$118 M	–	$108 M	+	–$9 M	=	$1 M

Figure 9

Institutional Financial Flow Design

Net Cash Balance Carried Forward From Last Year

Revenue
- + Average Tuition Per Student x Total Students
- + State Dollars to Higher Education Institutions
- + Other Dollars to Higher Education

Expenditure
- – Total Faculty x Inflated Average Faculty Expenditure
- – Inflated Average Administration and Support Expenditure Per Student x Total Students

Net Cash Balance Carried Forward to Next Year

only institutional revenues and expenditures, breaking them out in very little detail (in a more complete design, the components would still be revenues and expenditures, but they would be broken out into more detail). In this example, the institutional revenue includes tuition revenues, state dollars, and all other dollars. Institutional expenditures include faculty-related expenditures and all other expenditures for average administration and support expenditures on a per student basis. The net cash balance is used as an indicator of the fiscal viability of the institutions. In some states, institu-

tions are allowed to carry forward funds from one fiscal year to the next, and in others this is not the case. This further emphasizes the development of SPS design relationships to fit practices unique for a state rather than starting from one recommended design that assumes all finances are handled in the same manner. Notice that the financial flow is directly affected by the second state decision variable (state institutional aid) and indirectly by both state student aid and state institutional aid through changes in the total number of students and faculty.

For any set of SPS design relationships, some assumptions must be made to account for the impact of the outside environment (over which the state has no control), the validity of the relationships, and the data used. Some of the assumptions made in this example design are:

1. Institutional costs will increase at a 10% inflation rate.
2. Tuition will remain constant.
3. Other dollar revenue will remain constant.
4. The continuation rate for continuing students will be unaffected by any net change in cost, thus price changes affect only first-time students.
5. The design can be used without disaggregating institutions or students.
6. Facilities can be omitted from the design.
7. The institutional response to changes in state institutional financing is known relative to faculty hired.
8. State population will remain constant.
9. The measures of access, quality, and financial solvency are acceptable.
10. The data used are accurate enough for this example.

Many of these assumptions might be different in an actual analysis, but they do allow the illustration of this application of the SPS. Given the design relationships, assumptions, and initial data values, the impact on the state goals (access, quality, and net cash balance) of changes in the state decisions (student aid and institutional aid) can be determined. These impacts are shown in Figure 10. For example, an increase in state student aid (with institutional aid held constant) results in an increase in enrollment because of the resulting decrease in the net cost of attending higher education. This, in turn, results in an increase in the access ratio (enrollment over population), a decrease in the quality ratio (faculty over enrollment), and a decrease in the net cash balance (due to the fact that tuition does not pay 100% of the institutional cost for educating each student). Notice that an increase in institutional funding does not affect the number of students, and thus, there is no effect on the access measure for this set of design relationships. If such a relationship were necessary, it could be included in a revised set of design relationships.

The calculations may be more easily understood by referring to Figure 11. The input values to the simulation are used to calcuate a number of other values. The input and calculated variables are then

Figure 10

Illustrative Relationships Between State Decisions and Goals

State Decisions	Impact on State Goals
1. Increase Student Aid	• Increase in enrollment causing an increase in access measure • Increase in enrollment causing a decrease in quality measure • Increase in enrollment causing a decrease in net cash balance
2. Decrease Student Aid	• Reverse of the above impacts
3. Increase Institutional Aid	• No affect on access measure • Increase in faculty causing an increase in quality measure • Increase in net cash balance
4. Decrease Institutional Aid	• Reverse of the above impacts

Figure 11
Use of Input Values to Calculate State Goals

Independent Variables Input Values	Used to Calculate	Dependent Variables Calculated Values	Used to Calculate	Dependent Variables State Goals
Continuing Students 1973	94,000	Students Continuing into 1974	91,760	Access:
Continuation Rate for Continuing Students	.80	Total Students 1973	118,000	$\frac{\text{Students}}{\text{Population}} = \frac{118{,}000}{2{,}400{,}000} = \frac{1}{20.34}$
First-Time Students 1973	24,000			
Continuation Rate for New Students	.69			
Price Response Rate	.0012			
Initial Tuition	644.70			
Initial State Student Aid	44.00			
New Tuition	644.70			
*New State Student Aid**	44.00			
Continuing Faculty 1973	5,940	Faculty Continuing into 1974	5,979	Quality:
Continuation Rate for Continuing Faculty	.92	Total Faculty 1973	6,653	$\frac{\text{Faculty}}{\text{Students}} = \frac{6{,}653}{118{,}000} = \frac{1}{17.74}$
New Faculty	660			
Continuation Rate for New Faculty	.72			
Financing Response Rate for Faculty Hired	1×10^{-8}			
Initial State Institutional Aid	108,121,000			
Starting Net Cash Balance 1973	8,105,000			
*New State Institutional Aid**	108,121,000			
Other Dollars to Higher Education	143,355,000			
Inflated Average Faculty Expenditure	22,733	Ending Net Cash Balance for 1973 *or* for 1974	34,305,744	Financial Solvency: $34,305,744
Inflated Administration and Support Expenditure per Student	1,272			

* Decision values inputs for simulation.

used to calculate the state goals. Notice that the two decision variables (new state student aid and new state institutional aid) are input values in this simulation of the educational system.

Considering these design relationships, the assumptions, and the necessary data values, the analyst now has data on one side and a set of equations on the other such that a hand calculator could be used to calculate results simulating the higher education system. These results can be more easily computed, however, by using the SPS software. This will enable the analyst to perform the calculations many times during a policy analysis, changing certain data values before each run with little additional effort once the design is implemented in the SPS. The relationships and data also can be directly input to the SPS software rather than doing the calculations by hand. The results for the example application of such a computer simulation run, assuming constant state student aid of $44 per student and $108,000,000 to institutions, are graphically depicted in Figure 12. It can be seen that the access measure moved away from the goal of 1 in 17 that had been set. In the same way, the quality measure moved away from the goal of 1 in 20 to very near 1 in 15. And, finally, the net cash balance was originally around $34,000,000 but dropped to -$88,000,000 by 1976. Remember the assumptions included a 10% inflation rate applied to institutional expenses, no increase in tuition, and no increase in state institutional funding. In addition, federal and other dollars coming in were held constant, so that the institutional revenues remained constant while the institutional expenditures increased at a rate of 10% per year.

With the State Planning System, it also is possible to estimate the decision values necessary to achieve specified goals. This capability is called the optimization of decision variables as opposed to the simulation just discussed. In the simulation model only one sequence is made through all time periods in calculating the dependent variables, while in the optimization mode, the Simulation and Optimization Module (SOM) of the SPS changes the values of the decision variables and iterates through several simulations of the results. With each iteration, the optimization changes the decision variables, and the resulting measures of several of the goals move closer toward their target value so that the overall comparison of all goals is at least as close or closer to the overall targets.

The optimization values for this example design are shown in Figure 13. No constraints were placed on the range of decision values. Notice that institutional aid has increased steadily (over 40% per year), and the student aid has increased by more than a factor of 10 times (from $44 per student to an average of over $500) per student in order to achieve the access goal. Such a large increase in student aid is probably not feasible and limits can be placed on the range of acceptable decision values and a new optimization run made.

Identifying these results provides information about the level of state aid required to meet all three goals (access, quality, and financial solvency). Unfortunately, however, an important dimension to the problem has been ignored — that is, available state revenue—and this particular solution required unrealistic levels of state support. Approximately 86% of the state's budget would be spent on education under this solution. Since this figure is normally near 25%, the solution for achieving the original goals of access, quality, and financial solvency is not feasible. In using the SPS, the analyst could return to the start of the analysis and modify the policy problem statement as follows:

> What level of state student aid in dollars per student and state institutional aid in total budget dollars to institutions will come close to achieving state goals related to:
>
> Access to higher education
> Quality of instruction
> Financial solvency of institutions
>
> with the additional constraint that the total state higher education expenditures remain at a constant percent of state revenues (a balanced state budget)?

With the SPS, it is possible to include the additional relationship, setting 25% of the state revenues minus total higher education expenditures (institution and student aid) to zero as shown in Figure 14.

Figure 12
Policy Problem Simulation

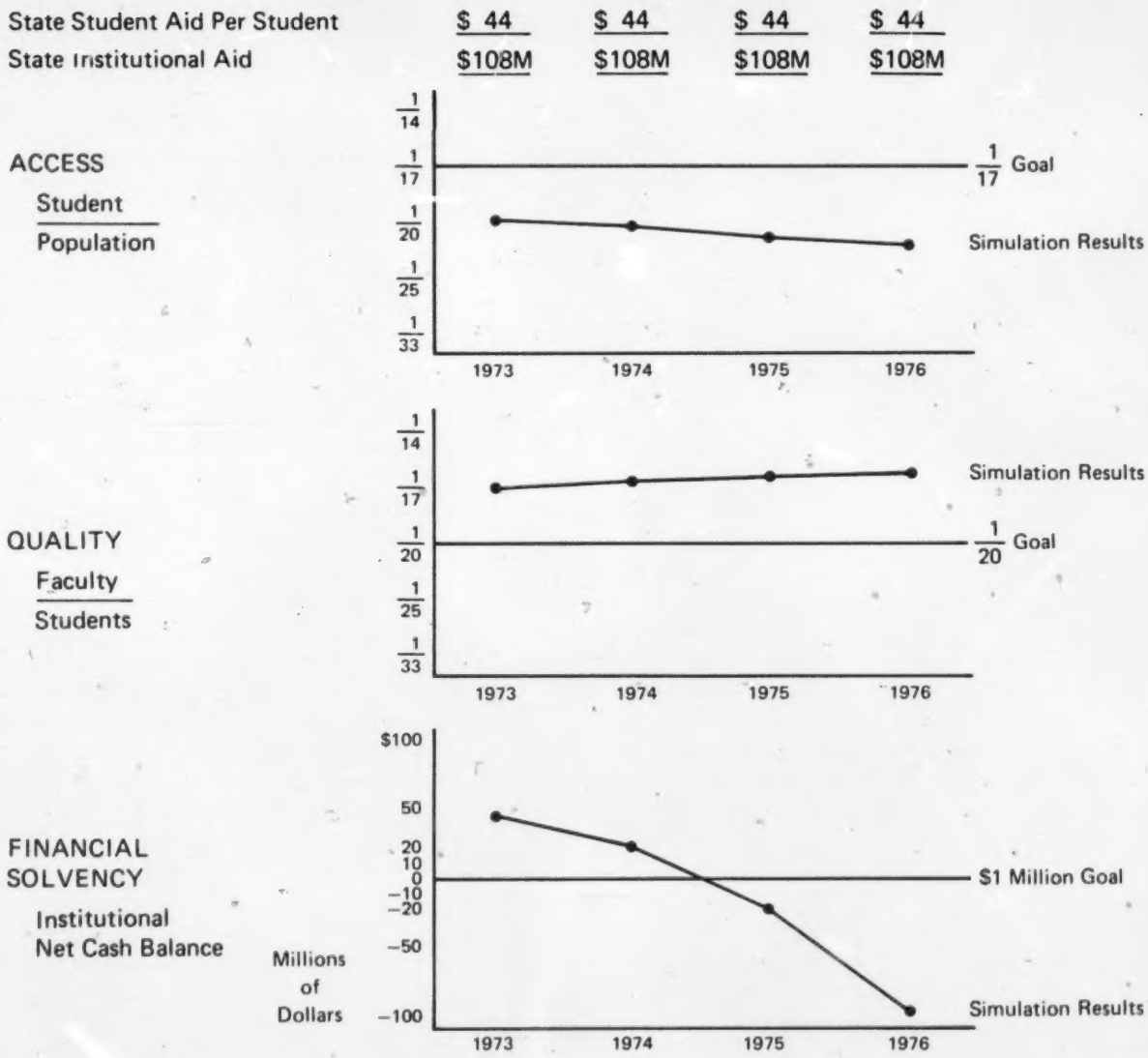
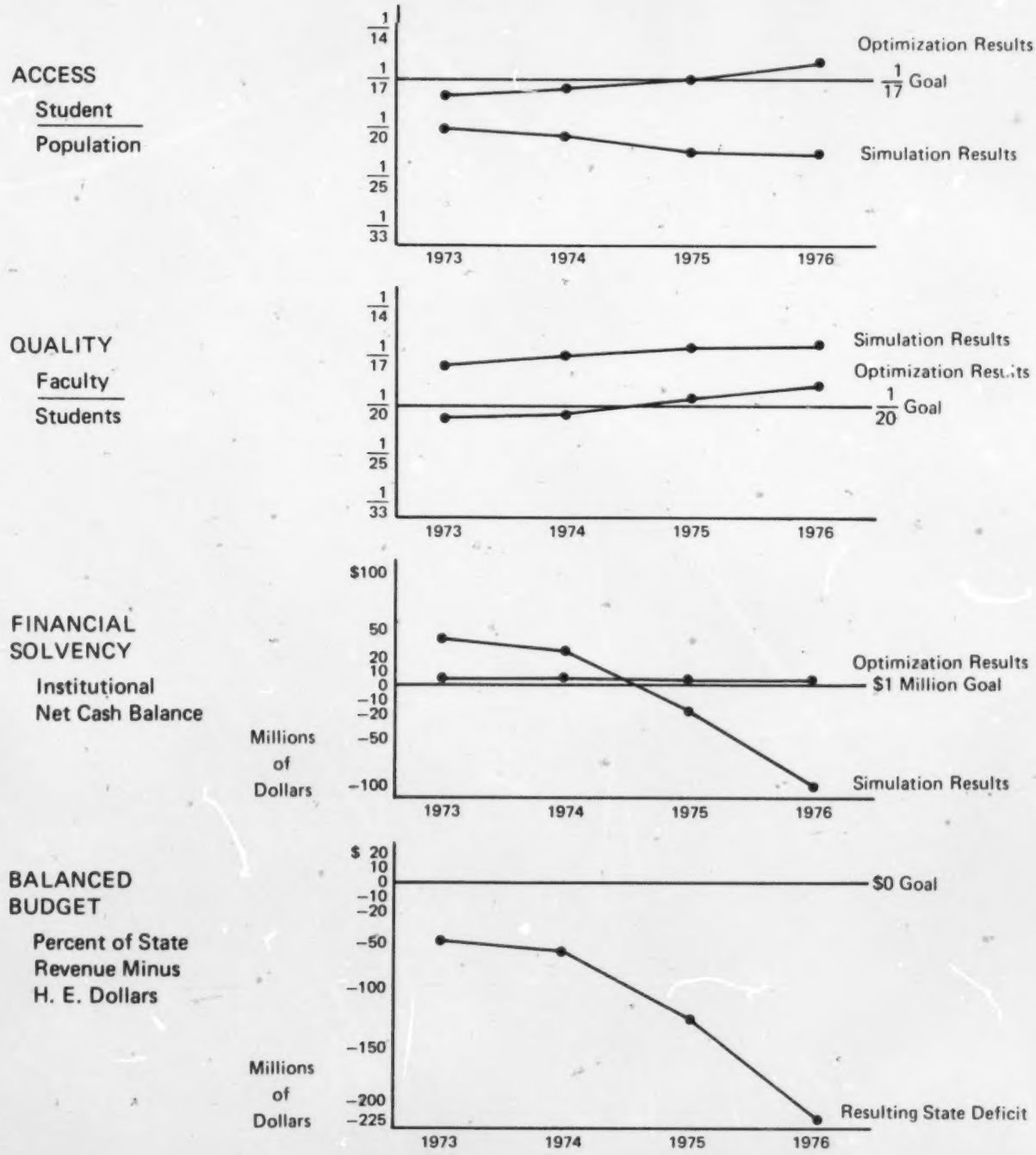


Figure 13
Policy Problem Optimization Results

State Student Aid Per Student	$ 646	$ 342	$ 428	$ 586
State Institutional Aid	$ 82M	$ 125M	$ 177M	$ 250M



It is not unusual to find it necessary to modify the design relationships and problem statement, and the SPS has been developed with the flexibility necessary to make such design changes. A new run can then be made to search for a set of decision values with a high priority on balancing the state budget. Figure 15 shows the results of this run (Optimization Results No. 2). The solution does come closer to balancing the state budget, but in terms of achieving quality and access, the results are not as good. In fact, the greatest financial deficit is now in the institutions' financial solvency. The various goals are conflicting, and in order to achieve financial solvency, the results will move away from achieving the access goal. To achieve one goal, concessions must often be made on the other goals. Tradeoffs can be made as to which goals are to be achieved, resulting in a more realistic solution since resources are usually not sufficient to achieve all goals at the same time.

Another modification to this example policy problem is to let the tuition vary as a decision variable as well as the state student aid and institutional aid. The results of the third optimization run with this modification are shown in Figure 16. Allowing tuition to fluctuate results in a solution where the state budget, institutional financial solvency, and quality measures come fairly close to their targets, but the access measure is still far from the desired goal. Again, a higher priority could be placed on achieving the access goal, but in turn the results would move away from one of the other goals.

To summarize, this example policy problem illustrates the steps necessary for using the SPS. The main difference between the steps in this example and the steps in an actual application would be the additional level of detail required by a more complex policy problem. In either case, the SPS serves the problem solving process by providing insights into higher education interrelationships that might not otherwise be visible to the decision maker.

Figure 14

Specification of Measures

State Goal	Measures	Current Values	Target Values 1973-1976
Access	Total Enrollment / Total Population	118,000 / 2,400,000 = 1/20	1/17
Quality	Total Faculty / Total Students	6,653 / 118,000 = 1/18	1/20
Financial Solvency	End of Year Net Cash Balance	$34 Million	$1 Million
Balanced Budget	Higher Education Expenditures Equal to a Percent of State Revenue	.25 X $452M – ($108M + $5M) = 0	0

Figure 15

Modified Policy Problem Optimization Results

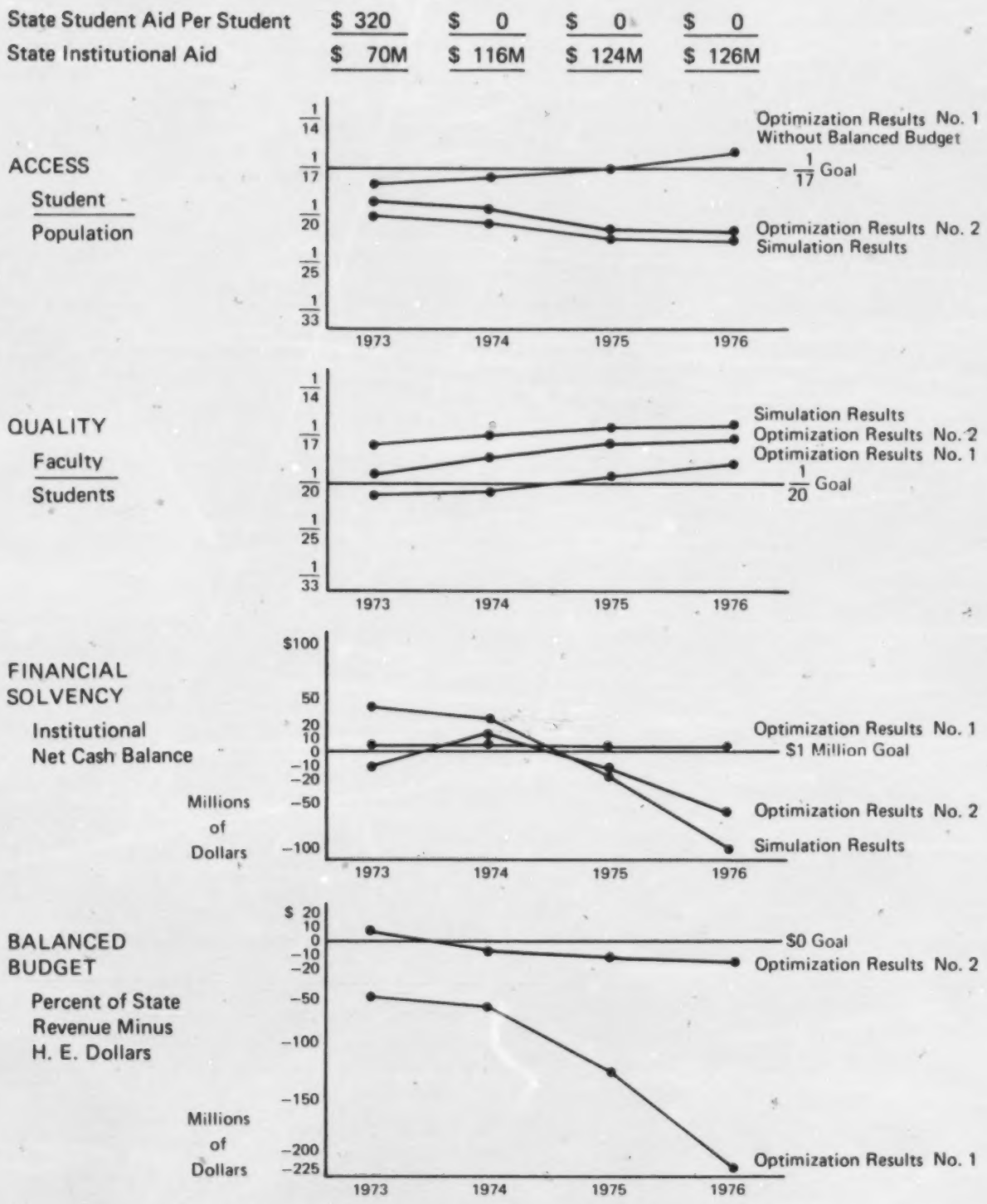
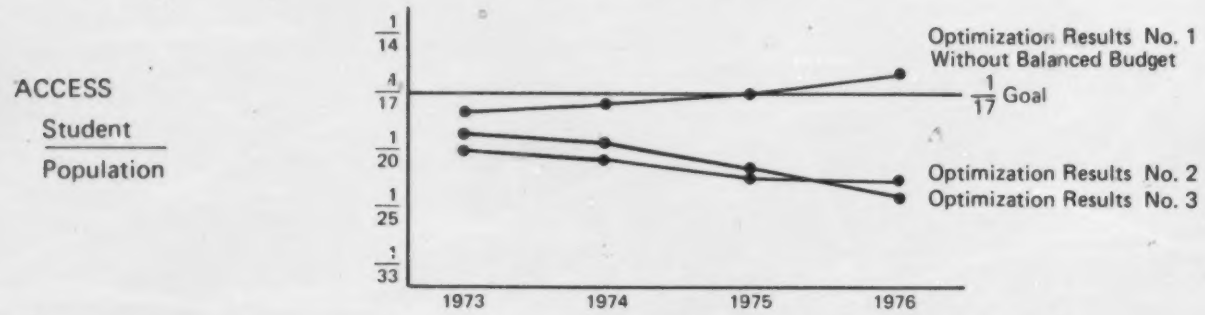
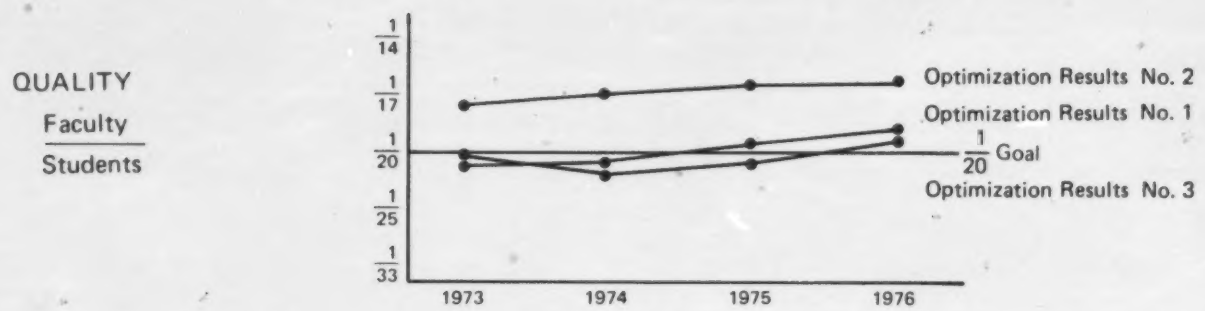


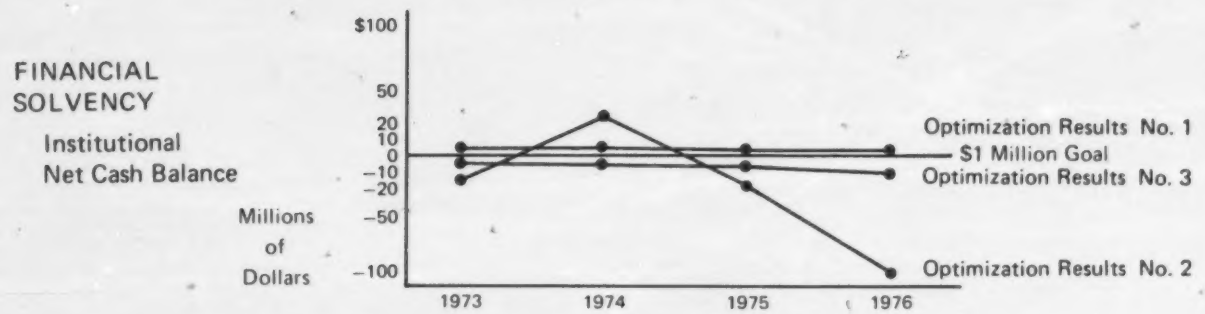
Figure 16

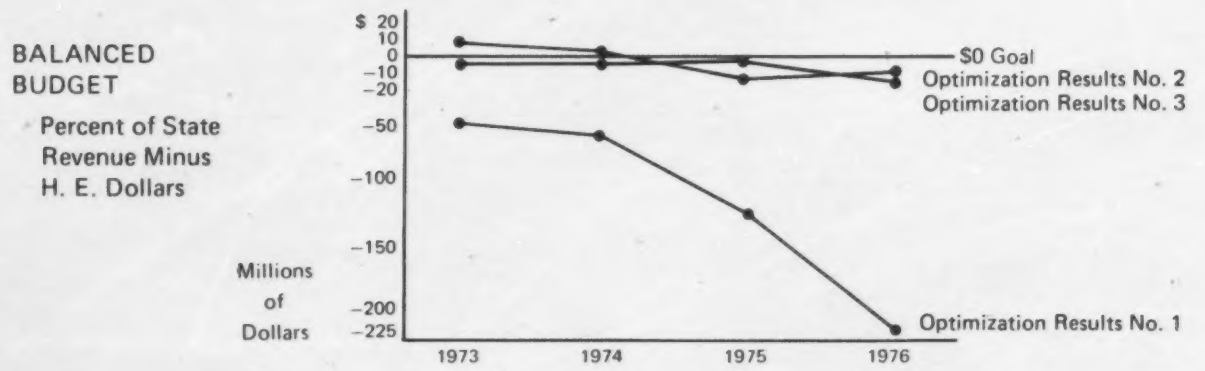
Modified Policy Problem with Tuition Variable

State Student Aid Per Student	$ 466	$ 444	$ 405	$ 314
State Institutional Aid	$ 55M	$ 59M	$ 67M	$ 81M
Tuition	$ 761	$ 991	$ 1124	$ 1205









Chapter IV

The SPS Data Report Module

The policy example discussed in the previous chapter considered only the calculation module of the SPS. With the SPS Data and Report Module (DRM), it is possible to make required data changes for any of the runs of the Simulation and Optimization Module (the calculation module), and to extract summary data from the results of several calculation runs (a detailed discussion of the DRM is contained in the *State Planning System Operation Guide*). For example, one useful report would be the end of year net cash balance values in all time periods for each of the different runs in Chapter IV. The results are given in Figure 17.

The intent of the DRM capability of the SPS is to allow the user to obtain summary reports on the information that has been calculated without having to look through a stack of computer printouts to find the results. DRM allows the user to obtain these summary reports immediately on an interactive computer terminal rather than waiting for a requested report to be printed at some remote location.

Another example of a DRM report (see Figure 18) could show the target value and calculated measure values for access, quality, institutional financial solvency, and balanced state budget for each of the four policy problem calculation runs, i.e., the initial simulation run (Figure 12), the optimization run number 1 to meet access, quality, and institutional financial solvency (Figure 13), the modified policy problem optimization run number 2 that included balanced state budget (Figure 15), and the optimization run number 3 that allowed tuition to vary (Figure 16).

The report capability of the SPS can also use the output data base from the Simulation and Optimization Module as an input to other report packages. For example, the output from the policy problem was used as input to the MARK IV File Management System* to produce the reports in Figures 19 and 20. Figure 19 shows the final values for state dollars to institutions, state student aid, and tuition per student over the time period 1977-1980 for the policy problem. Figure 20 shows the state-level measures and goals for the same problem. In this case, the MARK IV File Management System produced a more readable display format, even though the same report could be produced by the SPS report module with less effort (all required information is already in the computer and only has to be retrieved interactively), faster, and at less cost.

*The MARK IV File Management System is a proprietary software product developed, marketed, and supported by Informatics, Inc., MARK IV Systems Company. For further information, write 21050 Vanowen Street, Canoga Park, California 91303.

Figure 17
DRM Sample Output
End of Year Net Cash Balance

POLICY PROBLEM END OF YEAR	NCB	1973	1974	1975	1976
SIMULATION	RESULTS	34305743.60	26774252.90	-15550373.60	-38016783.60
OPT RUN 1	RESULTS	1106066.69	650191.33	358046.45	403140.37
OPT RUN 2	RESULTS	-3118788.59	3525078.62	-15471113.90	-64958554.80
OPT RUN 3	RESULTS	-731269.86	-1133819.43	-958824.56	-3622188.45

Figure 18

DRM Sample Output
State-Level Measures and Goals

POLICY PROBLEM

ONE

ACCESS(S/P)	TARGET	1973	1974	1975	1976
SIMULATION	RESULTS	5.88000E-02	5.88000E-02	5.88000E-02	5.88000E-02

ACCESS (S/P) TERM		1973	1974	1975	1976
SIMULATION	RESULTS	4.91667E-02	4.82333E-02	4.74867E-02	4.68893E-02
OPT RUN 1	RESULTS	5.64240E-02	5.68623E-02	5.86534E-02	6.18512E-02
OPT RUN 2	RESULTS	5.25023E-02	5.00069E-02	4.84356E-02	4.71786E-02
OPT RUN 3	RESULTS	5.28167E-02	5.16314E-02	4.88584E-02	4.47586E-02

TWO

QUALTY(F/S)	TARGET	1973	1974	1975	1976
SIMULATION	RESULTS	5.00000E-02	5.00000E-02	5.00000E-02	5.00000E-02

QUALITY (F/S) TERM		1973	1974	1975	1976
SIMULATION	RESULTS	5.63855E-02	5.93032E-02	6.12028E-02	6.04897E-02
OPT RUN 1	RESULTS	4.78559E-02	4.86028E-02	5.01684E-02	5.30645E-02
OPT RUN 2	RESULTS	5.08064E-02	5.40723E-02	5.69292E-02	5.83351E-02
OPT RUN 3	RESULTS	4.93720E-02	4.83059E-02	4.94193E-02	5.31784E-02

Figure 18 (Continued)
DRM Sample Output
State-Level Measures and Goals (Continued)

```
     THREE
     END OF YEAR  NCB TARGET
                                  1973          1974          1975          1976
SIMULATION      RESULTS  1000000.00    1000000.00    1000000.00    1000000.00
     END OF YEAR     NCB TERM
                                  1973          1974          1975          1976
SIMULATION      RESULTS 34305743.60  26774252.90-15550373.60-88016783.60
OPT RUN  1      RESULTS  1106066.69    650191.33    358046.45    403140.37
OPT RUN  2      RESULTS -3118788.59   3525078.62-15471113.90-64958554.80
OPT RUN  3      RESULTS  -731269.86  -1133819.43   -958824.56  -3622188.45

       FOUR
     BALAN STATE BDGT TARGET
                                  1973          1974          1975          1976
SIMULATION      RESULTS          0.00          0.00          0.00          0.00
     BALAN STATE BUDGET TERM
                                  1973          1974          1975          1976
SIMULATION      RESULTS  -313000.00   -214440.00   -135592.00    -72513.60
OPT RUN  1      RESULTS-5.67717E+07-5.92063E+07-1.24397E+08-2.25097E+08
OPT RUN  2      RESULTS  2431575.67  -3121722.82-10655332.10-12716354.50
OPT RUN  3      RESULTS  -731010.92   -954741.07  -1046003.67  -1037240.92
```

Figure 19

03/26/76

Mark IV Sample Output
Final Control Values

STATE DOLLARS TO INSTITUTIONS

	1973	1974	1975	1976
SIMULATION RESULTS	108,121,008.0000	108,121,008.0000	108,121,008.0000	108,121,008.0000
OPTIMIZATION 1 RESULTS	81,894,496.0000	124,809,008.0000	176,504,000.0000	250,375,008.0000
OPTIMIZATION 2 RESULTS	70,162,192.0000	116,260,000.0000	123,712,000.0000	125,800,000.0000
OPTIMIZATION 3 RESULTS	54,820,400.0000	59,195,696.0000	66,876,896.0000	80,759,504.0000

STATE STUDENT AID

	1973	1974	1975	1976
SIMULATION RESULTS	44.0000	44.0000	44.0000	44.0000
OPTIMIZATION 1 RESULTS	646.1841	342.3870	427.6321	585.9260
OPTIMIZATION 2 RESULTS	320.4980	.0000	.0000	.0000
OPTIMIZATION 3 RESULTS	466.3889	443.8101	405.3181	313.6741

TUITION PER STUDENT

	1973	1974	1975	1976
SIMULATION RESULTS	644.7000	644.7000	644.7000	644.7000
OPTIMIZATION 1 RESULTS	644.7000	644.7000	644.7000	644.7000
OPTIMIZATION 2 RESULTS	644.7000	644.7000	644.7000	644.7000
OPTIMIZATION 3 RESULTS	760.5049	990.8149	1,123.6699	1,205.2000

Figure 20

Mark IV Sample Output
State-Level Measures and Goals

03/26/76

ACCESS (S/P) TARGET

TIME	TARGET	TERM SIMULATION	TERM OPTIMIZATION1	TERM OPTIMIZATION2
1973	.0588	.0492	.0564	.0525
1974	.0588	.0483	.0568	.0500
1975	.0588	.0475	.0586	.0485
1976	.0588	.0470	.0618	.0472

QUALITY (F/S) TARGET

TIME	TARGET	TERM SIMULATION	TERM OPTIMIZATION1	TERM OPTIMIZATION2
1973	.0500	.0564	.0479	.0508
1974	.0500	.0593	.0486	.0541
1975	.0500	.0611	.0502	.0569
1976	.0500	.0604	.0531	.0583

Figure 20 (Continued)
Mark IV Sample Output
State-Level Measures and Goals (Continued)

END OF YEAR NCB TARGET

TIME	TARGET	TERM SIMULATION	TERM OPTIMIZATION1	TERM OPTIMIZATION2
1973	1,000,000.0000	34,269,600.0000	1,098,910.0000	-2,989,250.0000
1974	1,000,000.0000	26,670,592.0000	511,851.0000	3,677,570.0000
1975	1,000,000.0000	-15,746,000.0000	372,726.0000	-15,448,900.0000
1976	1,000,000.0000	-88,315,696.0000	375,644.0000	-65,101,696.0000

BALANCED STATE BUDGET TARGET

TIME	TARGET	TERM SIMULATION	TERM OPTIMIZATION1	TERM OPTIMIZATION2
1973	.0000	-315,534.0000	-56,388,192.0000	2,448,390.0000
1974	.0000	-218,723.0000	-58,516,304.0000	-3,259,650.0000
1975	.0000	-141,274.0000	-123,650,000.0000	-10,712,300.0000
1976	.0000	-79,314.8750	-224,281,008.0000	-12,799,900.0000

Chapter V

A Summary of Pilot-Test Results and Designs from Other States

The SPS was developed through the active participation of three pilot-test states. This chapter briefly describes the uses made of the SPS in the pilot-test states of Colorado, Maryland, and New York to illustrate the different applications and levels of complexity of actual uses of the SPS. The full case study reports can be found in the *State Planning System Case Studies* document. Other case studies will document the experiences of other states as those experiences are completed. Following this summary of the case studies is a discussion of some other designs that can be used in connection with the SPS.

The Colorado Case Study

The pilot-test case study of the SPS in Colorado was conducted by the Colorado Commission on Higher Education (CCHE). The Commission is the statutory agency for planning and coordination of higher education in Colorado and one of its responsibilities is to collect and analyze higher education statistics.

When the Colorado state legislature wished to establish a standard tuition policy for the public institutions in Colorado, the CCHE staff was asked alternative policies suggested by both the CCHE staff and the Joint Budget Committee of the state legislature.

The CCHE staff evaluation of each tuition policy alternative was to include a determination of the relative impact of each upon revenue expectations, upon students by categories, and upon institutions. The CCHE staff decided to use the SPS to carry out this study.

In conducting the case study application the CCHE had the following goals:

(1) To test the tuition alternatives and examine the relative impact of each upon revenue expectations, upon student access by category, and upon institutions.

(2) To examine the ease, flexibility, and extendability of the SPS as compared to other modeling techniques available to CCHE.

The information needed to examine the tuition alternatives had already been collected from public institutions throughout the state during Fall 1975. Tuition policy information and enrollment data (students taking 1-30 credit hours, in-state or out-of-state residency, undergraduate or graduate) was available for each institution. Working closely with the NCHEMS staff, the CCHE staff was able to formulate the SPS design, including identification of the required variables and measures, all within a period of two days.

The mathematical formulation of the model was developed by staff at CCHE. The CCHE staff had experience in design formulation, needing NCHEMS staff help only for the specifics of the SPS. Table 1 shows the total tuition revenue generated for each of the Colorado public institutions by each of the three different policies. In this table, the current policy set tuition at 25% of the cost of instruction for resident students and 100% of the cost of instruction for non-resident students with institutional governing boards determining the full-time/part-time student differential. The CCHE test policy was essentially the same as the current policy, but with 10 credit hours set as full-time for tuition purposes; one-tenth of full tuition for each credit hour from 1 to 10, and a minimum tuition equivalent to two credit hours. The Joint Budget Committee 1 test policy was also essentially the same as the current policy, except for a surcharge of 50% of the institutionally-set per credit hour rate for each credit over 15.

The purpose of this SPS report was to illustrate shifts in revenue distribution that would occur among institutions if Colorado moved from the current policy to either of the two test policies.

Table 1

Total Tuition Revenue

		COLORADO TUITION RUN -- CURRENT POLICY	COLORADO TUITION RUN -- CCHE POLICY	COLORADO TUITION RUN -- JBC1 POLICY
ARAPOHOE	COMMUNITY	255285.00	268596.00	263559.00
DENVER	COMMUNITY	850064.00	888092.00	893312.00
EL PASO	COMMUNITY	379141.00	392005.00	387042.00
LAMAR	COMMUNITY	35825.30	29703.90	44719.60
MORGAN	COMMUNITY	23886.10	26494.40	28025.80
OTERO	COMMUNITY	51496.50	44113.70	63767.80
TRINIDAD	COMMUNITY	123449.00	110821.00	165323.00
ADAMS	FOUR YEAR	445679.00	439063.00	478553.00
FT LEWIS	FOUR YEAR	913951.00	913118.00	942614.00
MESA	FOUR YEAR	399287.00	310442.00	422873.00
METRO	FOUR YEAR	1141080.00	1174010.00	1155830.00
SOUTHERN	FOUR YEAR	833280.00	810449.00	885781.00
UNIV N COLO	FOUR YEAR	1940450.00	1926720.00	2034500.00
WESTERN	FOUR YEAR	559839.00	558581.00	594536.00
COLO STATE	UNIVERSITY	7323180.00	7225590.00	7578360.00
MINES	UNIVERSITY	1135010.00	1133370.00	1245520.00
UC BOULDER	UNIVERSITY	11168500.00	10989100.00	11572200.00
UC CO SPRNG	UNIVERSITY	553644.00	636926.00	563109.00
UC DENVER	UNIVERSITY	1110670.00	1132940.00	1127410.00

The formulation can be described as follows: tuition revenue by tuition category was calculated by multiplying institutional enrollment by category times the tuition charge for that category. Calculated revenue was then summed over all tuition categories to obtain a total projected tuition revenue for each institution. The design did not calculate changes in enrollment levels in response to the alternative tuition policies. For the purpose of this analysis, it was assumed that enrollment would not be affected by the slight variations in tuition being considered.

The CCHE staff used the model to compute the several sets of tuition revenue measures in which they were interested and then to compare the several sets (or runs). An example of part of one of the reports of the measures produced by the Colorado design in given in Table 2. In this example, the current policy was the same as the "current policy" in Table 1 and the test policy was the same as the "JBC 1" test policy in Table 1. The same measures for all other public institutions were displayed in the remainder of the report. These measures proved especially useful for displaying the different distribution of revenue by type of student (see resident versus non-resident revenue) as compared to the distribution of enrollment.

CCHE staff members had extensive experience working with other simulation models of various types including CAMPUS, PLANTRAN, RRPM, and specially built simulation models. For a comparison to use in evaluating the SPS, CCHE staff chose EXIR-OMNITAB (a retrieval and statistical data management system).

In comparing the use of EXIR-OMNITAB and the SPS on the alternative tuition policies, the cost of the SPS measured in staff time and computer costs was about one-half the cost of EXIR-OMNITAB. Answers were obtained quickly with either system; however, the EXIR-OMNITAB system could not easily calculate the various measures of the distri-

Table 2
Computed Measures—Colorado Case Study

University of Colorado—Boulder Campus	Colorado Tuition *Current Policy*	Colorado Tuition JBC 1
Percent Resident Revenue	30.86	30.65
Percent Nonresident Revenue	69.14	69.35
Percent Undergraduate Revenue	83.61	84.42
Percent Graduate Revenue	16.39	15.58
Percent Resident Undergraduate Revenue	25.96	25.99
Percent Resident Graduate Revenue	4.90	4.65
Percent Nonresident Undergraduate Revenue	57.65	58.42
Percent Nonresident Graduate Revenue	11.49	10.93
Percent Resident Enrollment	65.34	65.34
Percent Nonresident Enrollment	34.66	34.66
Percent Undergraduate Enrollment	79.71	79.71
Percent Graduate Enrollment	20.29	20.29
Precent Resident Undergraduate Enrollment	51.65	51.65
Percent Resident Graduate Enrollment	13.69	13.69
Percent Nonresident Undergraduate Enrollment	28.05	28.05
Percent Nonresident Graduate Enrollment	6.60	6.60
Total Enrollment	21623.00	21623.00
University of Colorado—Colorado Springs Campus		
Percent Resident Revenue	67.16	67.05
Percent Nonresident Revenue	32.84	32.95
Percent Undergraduate Revenue	75.40	76.00
Percent Graduate Revenue	24.60	24.00
Percent Resident Undergraduate Revenue	51.74	52.02
Percent Resident Graduate Revenue	15.42	15.03
Percent Nonresident Undergraduate Revenue	23.66	23.98
Percent Nonresident Graduate Revenue	9.18	8.97
Percent Resident Enrollment	84.59	84.59
Percent Nonresident Enrollment	15.41	15.41
Percent Undergraduate Enrollment	64.09	64.09
Percent Graduate Enrollment	35.91	35.91
Percent Resident Undergraduate Enrollment	56.19	56.19
Percent Resident Graduate Enrollment	28.40	28.40
Percent Nonresident Undergraduate Enrollment	7.90	7.90
Percent Nonresident Graduate Enrollment	7.50	7.50
Total Enrollment	3278.00	3278.00

bution of tuition revenue by source. This capability was built directly into the SPS design.

The use of SPS was considered useful by the CCHE. A comprehensive tuition policy was identified which, when applied, appeared to provide improved access incentives with only small shifts in tuition revenue. The analysis reports were taken directly from the computer to the legislative Joint Budget Committee staff members, who found them understandable and useful in providing analytic input that assisted in determining the new Colorado tuition policy.

Frank Abbott, Executive Director of the Colorado Commission on Higher Education at the time, summarized the Colorado experience with the SPS this way:

> The Colorado Commission on Higher Education used several approaches to testing and assessing tuition policy alternatives during the past year, and found the SPS model to be the simplest, most efficient, and most flexible for our purposes. While it is my understanding that the technical potential of the SPS far exceeds the applications to which we put it, the capability to test a simple set of assumptions that are easily understood by nontechnicians and do not require extensive data bases as input proved to be a valuable feature of SPS.

The Maryland Case Study

The pilot test was conducted by the Maryland State Board for Higher Education, which functions as the coordinating body for Maryland's public and private colleges and universities. The board has the authority to approve all new programs, submit a recommended annual budget for all Maryland colleges and universities to the Governor, and submit a long-range master plan.

The first application of the SPS in Maryland by the Maryland State Board for Higher Education included a design that considered all aspects of the higher education system (students, faculty, facilities, and finances) as they relate to state-level objectives. The case study application of the SPS was not intended to research issues or to solve a specific single problem. The study was undertaken to develop a comprehensive planning model that could be used to provide input to current resource allocation and master planning discussions. The data for the Maryland application were taken for the most part from the state higher education budget documents and HEGIS reported data. Since the data formats of these sources differ in their level of detail, a full crossover between the budget categories and HEGIS financing categories was included in the design.

The Maryland design considered revenues and expenditures in 12 major financing program areas:

1. Instructional
2. Library
3. Administration
4. Student services
5. Specific institutional activity
6. Plant operation
7. Public safety
8. Research
9. Public service
10. Auxiliary enterprises
11. Desegregation programs
12. All other programs

The design allowed questions to be asked about 63 different state-level control or decision variables spread over the following categories:

1. Changes in enrollment
2. Tuition level
3. State revenues by financing program
4. Change in the number of faculty and administrators
5. Change in salary for faculty and administrators
6. Changes in authorized positions for faculty and administrators
7. Net changes in the assignable square feet of the facilities

Progress towards state-level goals could be measured by the following:

Based on this complex set of relationships, the Maryland staff considered the impact of a large range of questions on the state higher education system. For example, what would be the impact of achieving an existing Maryland goal of setting a faculty salary equal to the 75th percentile of salaries in comparable institutions nationally? Another question was what would be the impact on the state-level goals if the financing formula for the community college system was revised extensively?

Sheldon Knorr, Commissioner of the Maryland State Board for Higher Education, says:

> SPS allows Maryland to set statewide goals and determine the feasibility of reaching those goals. It has great potential because it is easy to use, requires little effort to make changes in the designs, and is inexpensive to operate.

A second application of the SPS in Maryland used the price response relationships used by Carlson* and the financing relationships determined by a committee representing Maryland higher education institutions to investigate an optional tuition policy. In this case the state's decision variables were the level of tuition to be charged at two-year, four-year, and university institutions. The state goals to be achieved were to maximize enrollments and minimize state expenditures on higher education.

The New York Case Study

The pilot test was conducted by the Board of Regents of the University of the State of New York (the State Education Department), which serves as the coordinating and supervisory agency for all levels of education, public and private, including adult and vocational education. The board has statutory responsibility for planning and coordinating all segments of postsecondary education.

The pilot test by the New York State Education Department was an extensive research effort. The intent was to explore the applicability of large-scale quantitative models to postsecondary education policy-making situations, and thus to determine if such tools could aid planners in achieving the effective allocation of resources. Thus the New York case study did not focus on a specific problem as did the tuition study in Colorado. Rather, the consideration was more toward a research project and the preparation of a general model to answer many questions in the area of resource allocation.

The specific application of SPS tested in New York used a complex set of data relationships, including data on students, student aid, institutional expenditures and revenues, state financing, and state-level goals for five institutional sectors: (1) SUNY—4-year, (2) SUNY—2-year, (3) CUNY—4-year, (4) CUNY—2-year, and (5) independent institutions. The data for this effort were taken from the New York enrollment projections, the Higher Education General Information Survey files, the state budget for higher education, and the state award schedule for funding such programs as the Aid to Non-Public Institutions (Bundy Aid) and the Tuition Assistance Program (TAP).

The following is a summary of the components in the New York design:

Cost to Student Component: The cost to student component dealt only with costs related directly to institutions (for example, tuition). It did not consider living costs (such as room and board) or travel cost.

Enrollment Component: It is assumed that once enrolled, students progress through the institutions in a fixed pattern (that is, an increase in tuition does not affect retention rates). The enrollment adjustment portion of the relationship was based on coefficients developed in 1976 using recent New York student data.

Institutional Expenditure Component: The institutional expenditure component was based on a very simple procedure for relating expenditures to enrollment. Only the educational and general expenditures were included in the current relationships.

Student Aid Component: This component reflected the New York TAP (Tuition Assistance Program), but did not include programs for the disadvantaged and federal programs. These programs could be considered in future versions of the design.

Institutional Revenue Component: Educational and general revenues were included as variable revenues and sponsored research and revenues from federal sources were included as fixed revenues.

State Contributions to Higher Education Component: The objective was to minimize state expenditures for higher education while still meeting current enrollment projections. It did not take into account other state programs.

*Daryl E. Carlson, *A Flow of Funds Model for Assessing the Impact of Alternative Student Aid Programs*, Research Memorandum EPRC 2158-28 (Menlo Park, California: Educational Policy Research Center, Stanford Research Institute, November, 1975).

All these components were interrelated in the New York design and affected by the following control or decision variables:

1. Average tuition costs by the different institutional sectors
2. The number of first-time, full-time freshmen students turned away by each institutional sector
3. The part-time undergraduate enrollment in each institutional sector
4. Full-time graduate enrollment in each institutional sector
5. Part-time graduate enrollment in each institutional sector
6. The additional state institutional aid (above funding formula aid) to the private institution sectors
7. Additional state aid per full-time undergraduate student by different income groupings of students.

The SPS calculations then demonstrated the impact of the control variables on state-level enrollment objectives (for full-time undergraduates, part-time undergraduates, full-time graduates, and part-time graduates); on maintaining a balanced budget for the private sector; and on minimizing state outlays for different institutional sectors. The details of the equations are documented in Technical Report 91, *SPS Case Studies*.

Based on this complex design and the interrelationships, the New York staff could consider the impact of a very large number of questions. For example:

1. What would be the impact on higher education enrollments and finances of the new tuition policies that are going into effect in fall 1976?
2. What would be the impact of the new Bundy Aid formula?
3. What would be the impact of the new higher education financing strategy suggested in the Regents Tentative Statewide Plan?

The testing of the New York model included extensive use of the optimization capability of SPS and review by the Department of Education's Planning Advisory Committee, composed of representatives from the institutional segments and other state legislative and executive agencies. Based on this review, New York intends to use the SPS design, or future modifications of it, for further examination and assessment of postsecondary education financing alternatives in New York.

In the full report on the New York results, T. Edward Hollander, Deputy Commissioner for Higher and Professional Education at the time, summed up the results of the project by stating:

> The Policy Analysis and Planning Project was undertaken to answer the question: Can powerful computers and sophisticated quantitative techniques aid postsecondary education planners and policy makers for more effective decision making and resource allocation? It would appear from the report that the answer is in the affirmative.

These case studies by the pilot-test states provide some idea of the ability of the SPS to consider a broad range of questions of interest at the state level. The results of the pilot-test work in the states have served another important function—testing and evaluation of the SPS software so that any new user can be assured that the product is ready for use.

Other Applications

The discussion of some of the potential areas of state planning to which the SPS can be applied (Chapter II) and the pilot-test state case study applications earlier in this chapter provide an overview of the SPS potential. In the remainder of this chapter, three other applications of the SPS are discussed to further illustrate the applicability of the SPS to a range of ongoing analytic efforts.

The first is a small faculty tenure analysis problem requiring only one or two weeks of time. The second applies the SPS to an existing financing model (or formula) to determine the impact of the financing model, and of variations of it on institutions and students. The third describes installation of an existing state-level design (a state-level adaptation of RRPM) as an input design to the SPS to take advantage of the ease with which design modifications can be tested with the SPS.

The small analysis problem involves the projection of faculty tenure percentages. This problem was analyzed in Virginia in 1976 using a variation of a model developed by President John G. Kemeny of Dartmouth College. In the model (shown in Figure 21), each institution begins the base year with "x" faculty members who are in the nontenured category, and "y" faculty members in the tenured category. At the end of the base-year period, some proportion, "p_1," of the nontenured faculty do not return to the institution and some proportion, "p_2," of the nontenured faculty are promoted to tenured status the following year. Similarly, some proportion, "p_3," of the tenured faculty do not return. The model assumes that all faculty who depart are replaced by full-time, nontenured faculty.

A small computer program was developed by the Virginia staff (the coding and programming took approximately one week of staff time) so that each institution could test tenure projections for the next decade. Most of that time was invested in preparing the computer code that would input data into the model and produce printed output. Only 25% of the computer statements were involved in the actual calcuations.

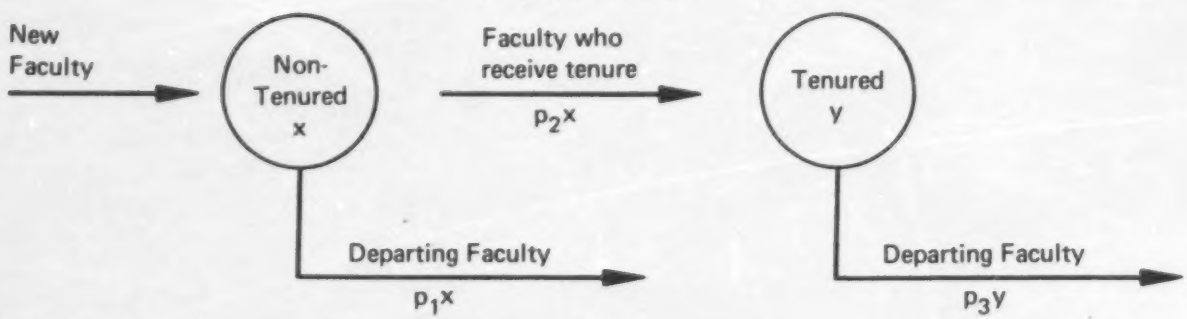
There are several points to be made from this example:

1. The SPS can save development time by eliminating much of the frequently associated computer work. The same set of relationships was installed and operational on the SPS in one day.
2. The analyst using the SPS can concentrate on the analysis relationships, not the problems of getting data into and out of the models.
3. The SPS is useful for short analysis efforts—it need not be restricted to long-term projects.
4. The SPS can be used to work on existing state-level projects.

In an increasing number of states, attention has been given recently to the development of specific financing models. These models contain the formulas for determining the financing allocations for the state. Although the models are similar in many ways, they all contain specific variations necessary for the characteristics of the states. The Oregon "Resource Allocation Model for the Oregon State System of Higher Education" is an example of an application of the SPS to an existing financing model (or formula) to determine the impact of the proposed formula on institutions and students. The full CORA/A model contains financing formulas for Instruction, Non-Sponsored Research, Academic Support, Student Services, Physical Plant Operations and Maintenance, and General Administrative Support. The following formula for the instructional budget illustrates the type of relationships

Figure 21

Virginia Tenure Projection Percentage Model Diagram



The tenure ratio is simply $\frac{y}{x+y}$.

contained in the model:

Total Instructional Faculty =

$$\frac{\text{Student Credit Hours}}{\text{Average Student Credit Hours per FTE Faculty}}$$

Total Instructional Faculty Salary =
Average Annual Faculty Salary x Total Instructional Faculty

Department Administration Cost =
Fixed Percent x Total Instructional Faculty Salary

Administrative and Clerical Support Cost =

$$\text{Average Salary} \times \frac{\text{Total Instructional Faculty}}{5}$$

The important points are not the specific content of these formulas since they would differ from state to state; rather that such a set of formulas is best pretested to determine its potential impact on students and institutions. The SPS can accept formula relationships as an input and, with data values, estimate their potential impact. The flexibility of the SPS permits each proposed formula change to be analyzed more readily than if a separate computer program was used for each version.

A specific example of the installation of an existing state-level design as an input design to the SPS is the Statewide Planning and Budgeting System (SPBS) developed by Robert A. Huff while he was at the Virginia Polytechnical Institute. This is an adaptation to the state level of the NCHEMS institutional Resource Requirements Prediction Model (RRPM). The SPBS is intended to provide states with the capability to simulate a multicampus budgeting process. The relationships shown in Figure 22 illustrate the enrollment distribution component of the model, which is then used, through an induced course load matrix, to project a program cost budget.* If a user wants a slightly different design formulation, it may be easier to adapt variations of the design using the SPS than by making program changes in the original software. The important point concerning SPBS and other similar products available at the state level is that this design (and any desired modifications) can be used as an input design for the SPS. This may make it easier to modify and add capabilities to the design, e.g., multiple-year projections.

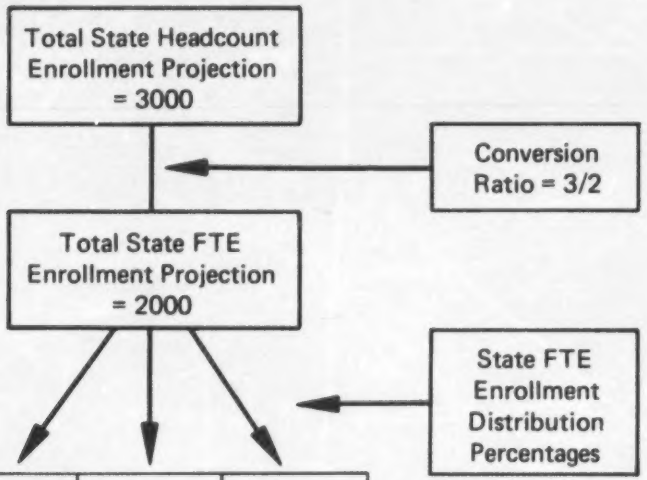
The examples in this chapter are intended to illustrate the applicability of the SPS to a variety of operational modes of state-level planning and to a variety of existing and new planning studies and state-level models.

*For a full discussion of the model, see Robert A. Huff, *Introduction to the Automated Statewide Planning and Budgeting System* (Blacksburg, Virginia: Virginia Polytechnic Institute and State University, College of Education), August, 1975.

Figure 22

Illustrative Calculations:

Statewide Planning and Budgeting System,
Enrollment Distributions Component


Total State Headcount Enrollment Projection = 3000
Conversion Ratio = 3/2
Total State FTE Enrollment Projection = 2000
State FTE Enrollment Distribution Percentages

Institutions and Student Levels / Program Clusters		Social Sciences	Physical Sciences	Letters	
University	LD	160	125	105	
	UD	200	125	105	
	GD	120	100	70	
State College	LD	120	50	70	
	UD	80	50	105	
	GD	40		105	
Community College	LD	80	50	140	
FTE Totals		800	500	700	2000

Chapter VI

SPS Implementation Assistance

Pilot test experience suggests that the initial installation of the SPS for a user benefits from NCHEMS staff assistance. The usual NCHEMS implementation assistance package for initial installation includes:

1. Training for all institution or agency staff that may be involved in the use of the SPS. Technical examples and exercises are used to give the institution or agency staff and advisory committees the expertise necessary to begin using the SPS.
2. Assistance in installing the SPS software on the state's computer. The current SPS software is designed to operate in an interactive timesharing mode or in a batch background environment and has been installed on Control Data, Honeywell, IBM, and UNIVAC computer systems that support an ANSI FORTRAN compiler, an editor package, and a sort package.
3. A design meeting to establish the set of design equations applicable to the selected policy problem. The design equations are one of the inputs to the SPS.
4. Assistance in assembling (not collecting) the required data into the correct format for the SPS.
5. Assistance in validating the initial design based on data for prior years.

The SPS has been used by individuals having minimal computer expertise. However, the staff at the computer center where the SPS software will be installed should be able to install it and test it for operation. Such efforts should take no more than two to three days. The primary in-staff expertise required is a competent analyst familiar with operations research concepts and interested in new planning and management tools. Such a person should be able to use the SPS effectively if initially assisted by an NCHEMS training experience or by another analyst familiar with the design of the SPS relationships, with the operation of the SPS, and with the analysis of the output results.

A non-SPS analytical project that will take six or more weeks of staff time should be adaptable to SPS by the average state-level staff in the same time period. After an initial successful effort using the SPS, a state should be able to apply the SPS to a range of analytical tasks from short two- or three-day efforts to larger tasks taking several staff and several months of effort. The SPS encourages extension of an analytical task beyond what could be done manually. Thus, the total analysis time may become longer, but increased flexibility and an analytic capability result.

The assistance outlined above can be provided by NCHEMS through a service-for-fee contract. The cost of this service can vary, according to the amount of assistance required, but a typical contract would provide 20 days of NCHEMS staff support for $5,000. This fee would also cover some travel expenses, a copy of the software, and copies of the documentation.

There are some other expenses that can be expected in a first application of the SPS to a medium-sized problem.

The actual assembly and translation of data into the SPS file format may average about one week of time for one FTE staff with approximately $100 of computer cost. A general estimate of the staff time required to successfully integrate the SPS as an effective state-level tool over a three-month time period is:

Staff Analyst - 40-60 days of one staff member
Supervision - 6-8 days of one staff member
Advisory - 3 days of several advisors.

Computer costs are difficult to estimate, but a minimum budget of $1000 should be allowed for a medium-sized application of the SPS. Factors to be considered in estimating computer costs include:

1. The size of the design (the total number of variables)

2. The use of simulation only or optimization in the analysis (optimization increases the computer costs).
3. The type of design relationships—simple linear equations or complex nonlinear equations.
4. The billing or charging algorithm (formula) used by the computer center where the SPS will be used. This may have the greatest impact since experience has shown that cost difference of 15 times can be experienced for the same problem at different computer centers.

Once installed, the SPS is intended to operate without continuing NCHEMS staff assistance. Staff turnover, attempts to develop unusally complex designs, or the lack of a staff capability in operations research or computer sciences may suggest a need for additional assistance from time to time. To the extent that requirement extends beyond the limits of the technical assistance package, NCHEMS can provide additional assistance at a negotiated rate.

Glossary

This glossary contains a number of terms that are associated with the State Planning System. The index which follows provides references to the SPS documents for these terms as well as for other terms that are not listed here.

Constant Value (K). An SPS variable type used to store values that are fixed throughout a run of SOM.

Control Variable (C). An SPS variable type used to store values that may be modified by SOM if an optimization run is made.

Data and Report Module (DRM). The data manager and report writer for the SPS. DRM can create the data base and description file used by SOM and can produce tables or plots of the results of one or more runs of SOM. Other uses of DRM are to: (1) produce summaries of the data base and description files, (2) produce a listing of the design file values, (3) produce update files to modify data values before a run of SOM, (4) write subsets of data base or description files, (5) produce files used to modify existing data base or description files, and (6) sort small data base or description files.

Data Base File (DB). A file which contains all the data values used by a design. Each data value is identified by the time period, variable type and index, sector, and run number associated with that value.

Description File (DC). A file which contains all the labels (descriptions) used to identify the output of an SPS design. These labels are provided by the user to identify each variable used in a design.

Design. The overall set of relationships, data identifiers, and control parameters used in an SPS application.

Design File (DF). A file which provides the definition of an SPS design. The design file describes the number of variables, number of planning periods, basic design characteristics, and labels of a design.

Design Subroutines File (DS). A file which contains the actual relationships used in an SPS design. The design subroutines (consisting of three FORTRAN subroutines with a standard calling sequence, STATE, TERMS, and MSRS) are provided by the user. These routines are called by SOM when making a run.

Dynamic Variable (D). An SPS variable type used to store computed values that flow from one time period to the next.

Exogenous Value (E). An SPS variable type used to store values that are fixed throughout a run of SOM.

Index. A key used to identify a variable of a given type; each variable in an SPS design is identified by its SPS variable type and by an index value. For example, control variables one, two, three, four, etc.

INTABL. The standard instruction table file which must be provided for each run of SOM and DRM.

Key. An identifier used in the SPS to identify records and link file types together. The six SPS keys are: design, run, sector, type, index, and time.

Lagged Data References. The incorporation of historical data values in design equations.

Lower Bound (L). An SPS variable type used to store the lower bound for its associated control variable.

Measure Variable (M). An SPS variable type used to store values, calculated within a time period, that are used only for reporting purposes.

Merge Module (MRG). The file merger for the SPS. MRG can append the results of several runs of SOM together so that DRM can be used to produce reports comparing the runs. MRG can also modify existing data base or description files by merging them with special modification files produced by DRM.

Modify Data Base File (MDB). A small data base file created in DRM and used with MRG to modify an existing data base file.

Modify Description File (MDC). A small description file created in DRM and used with MRG to modify an existing description file.

MSRS Subroutine. The standard routine used to compute the measure values in the design subroutines file.

New Data Base File (NDB). The new data base file created by a run of SOM, DRM, or MRG.

New Description File (NDC). The new description file created by a run of DRM or MRG.

Optimization. The capability of SOM to adjust the control variables in a design to bring the term variables closer to their target values.

Print Switches. Values on the design file that are used to control the output produced by SOM.

Report File (RP). The output file of reports produced by SOM. It can be saved for later listing on a terminal or a line printer.

Run Number. The key value used to identify each data base produced by a run of SOM.

Run-Time Updates. Temporary modifications to certain design file values that are made during the course of a run of SOM.

Scale Factor (A). An SPS variable type used to store the scale factor for its associated control variable.

Sector. A grouping of data in an SPS design corresponding to one component of the design (e.g., a particular institution or a set of similar institutions). They are distinguished from each other by the sector key.

Sector Communication Table (SCT). The specification of the data values that are to be passed from one sector to another during a run of SOM. Unlike the DS, DB, DC, and DF files, the sector communication table file is not used with every SPS design.

Simulation. The capability of SOM to calculate the static, dynamic, term, and measure values for all the time periods in a design.

Simulation and Optimization Module (SOM). The computational module for the SPS. SOM is used for either simulation or optimization runs with the designs specified in the SPS data files. SOM produces certain standard reports on request and a new data base file containing the results of the current run.

STATE Subroutine. The standard routine used to compute the dynamic and static values in the design subroutines.

Static Variable. An SPS variable type used to store values computed within a time period.

Subdesign. The relationships and characteristics of an SPS design that apply to at least one sector. There may be several subdesigns in an SPS design and they are distinguished by the design key.

Subroutine. A unit of FORTRAN computer code that makes up part of a complete program. The user supplies the three design subroutines to SOM for each SPS design.

Target Value (T). An SPS variable type used to store the goal or desired value of its associated term variable.

TERMS Subroutine. The standard routine used to compute the term values in the design subroutines.

Term Variable (R). An SPS variable type used to store the calculated value of a design objective within a time period.

Time Period. The units of time in an SPS design. The values are determined by the user (that is, the time periods can be academic years, fiscal years, semesters, etc.) and are distinguished by the time key.

Update File (UP). The file used as an update to the data base during a run of SOM. It is created as an NDB file in DRM.

Upper Bound (U). An SPS variable type to store the upper bound for its associated control variable.

Variable Types. The set of twelve allowable variable types used in constructing a design for the SPS.

Weight Value (W). An SPS variable type used to indicate the relative importance of its associated term variable in a design.

Index

This index combines entries for all 12 State Planning System documents. Each entry is followed by a subentry for each document that contains a reference to that subject. The documents are abbreviated in the subentries as follows:

I	*Introduction to SPS*
M	*Modeling and SPS*
CS	*SPS Case Studies*
DP	*SPS Data Procedures*
DG	*SPS Design Guide*
GTM	*SPS General Training Manual*
ISTM	*SPS In-State Training Manual*
OG	*SPS Operation Guide*
SD	*SPS Software Documentation*
SIG	*SPS Software Installation Guide*
SOI	*SPS Summary Operating Instructions*
TC	*Theoretical Concepts Used in SPS*

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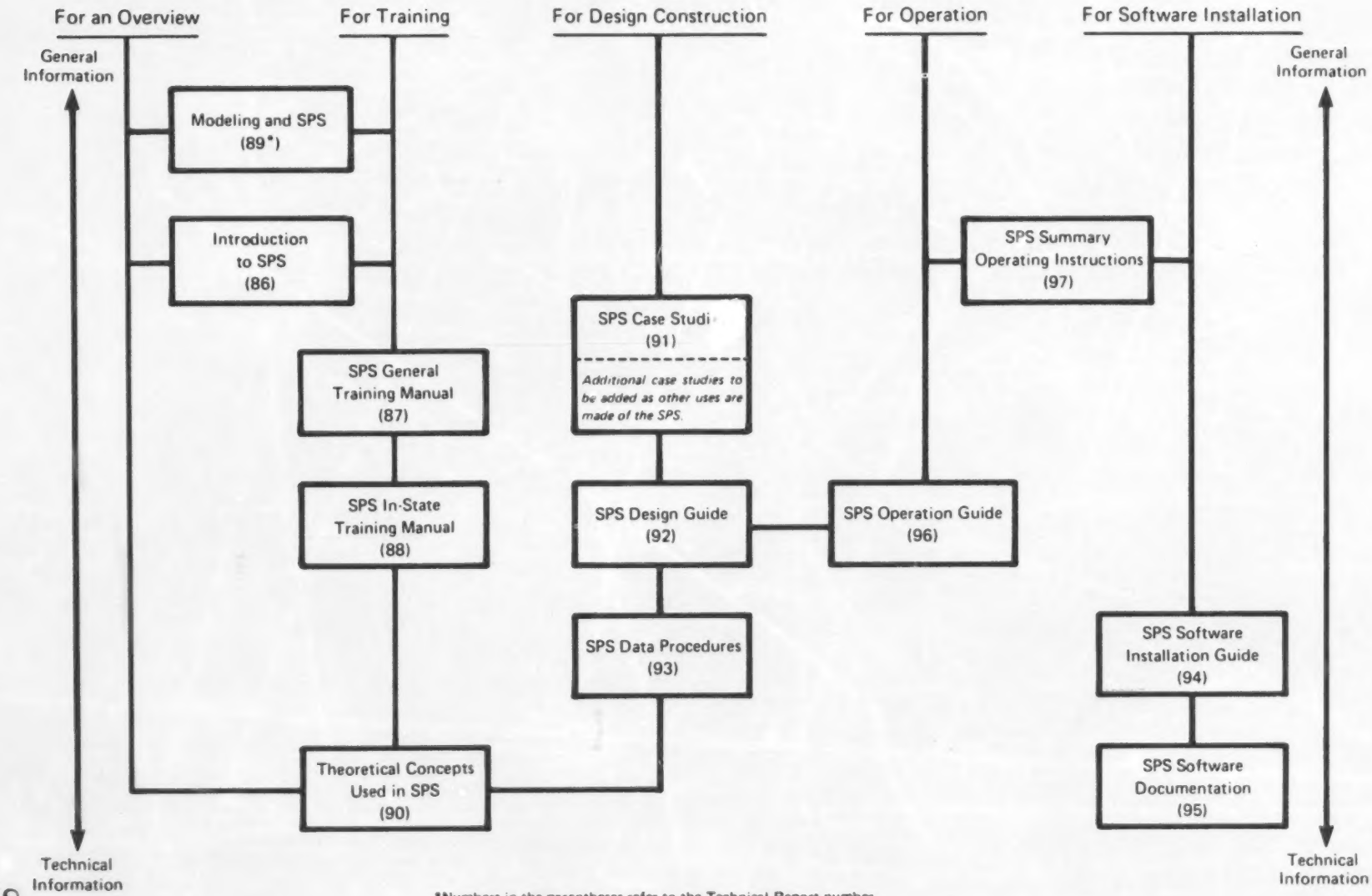
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For Operation
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